

MONTHLY WEATHER REVIEW,

JULY, 1879.

(General Weather Service of the United States.)

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

INTRODUCTION.

In preparing this REVIEW the following data, received up to August 13th, have been used, viz: the regular tri-daily weather charts, containing the data of simultaneous observations taken at 124 Signal Service stations and 12 Canadian stations, as telegraphed to this office; monthly journals and means 137 and 140 respectively, from the former; reports from 37 Sunset stations; 223 monthly registers from Voluntary Observers; 43 monthly registers from United States Army Post Surgeons; Marine Records; International Simultaneous Observations; monthly reports from Voluntary Observers in, and the local Weather Services of, the States of Iowa and Missouri; reliable newspaper extracts; special reports.

BAROMETRIC PRESSURE.

Upon chart No. II is shown by the isobaric lines the general distribution of atmospheric pressure, as reduced to sea-level, for the month.

The Local Barometric Ranges have varied as follows: Pacific Coast 0.50 at Roseburg to 0.22 at San Diego; Western Plateau, 0.41 at Virginia City to 0.24 at Boise City; Rocky Mountains, 0.33 at Denver to 0.26 at Santa Fe; summit of Pike's Peak, 0.30; Gulf States, 0.41 at Montgomery to 0.22 at Punta Rasa and Key West; Atlantic States, 0.78 at New York city to 0.43 at Jacksonville; summit of Mt. Washington, 0.63; Ohio valley and Tennessee, 0.62 at Pittsburgh to 0.38 at Cairo; Lake region, 0.79 at Rochester to 0.60 at Chicago; Northwest and Eastern Slope, 0.69 at Pembina to 0.40 at Deadwood and Leavenworth.

Areas of High Barometer.—Of these, three have been sufficiently marked to merit a description.

No. I.—This area, central in New York on the morning of the 1st, moved almost due south, and passed off the North Carolina coast the evening of the 2nd. Maximum abnormal barometric pressures of +0.31 at Albany morning of the 1st, and of +0.32 at Cape Henry the morning of the 2nd, were reported. Generally clear weather, with no precipitation, prevailed during its passage in the New England and Middle Atlantic States. This area caused the minima temperatures for the Southern Atlantic and a portion of the Middle Atlantic States. A minimum temperature of 38° was reported from Rockcliffe the morning of the 1st, and light frost at Hector, Starkey and Niles, N. Y., and Springfield, Mass. Brisk northerly winds prevailing on the North Carolina coast the morning of the 1st, Cautionary Signals were displayed. They were lowered that afternoon, having been justified with a maximum velocity of 28 miles NE. at Cape Lookout. Maximum velocities of 25 miles on the 1st and 26 miles on the 2nd were reported from Cape May.

No. II.—From its influence on the Northwestern barometers on the 3rd, it is evident that this area was then central in Saskatchewan, and by the morning of the 4th had reached Manitoba; Bismarck barometer 0.14 abnormally high. Moving nearly due east, accompanied by light to fresh northerly winds and generally clear weather, it reached Ontario the morning of the 5th; Rockcliffe barometer 30.34. At that time clear weather, with fresh NE. winds, generally prevailed on the Lower Lakes and New England; cloudy weather, with brisk north to high north winds, in Middle Atlantic, and brisk westerly winds on North Carolina coast. Maximum velocity had been reported of 25 miles W. at Hatteras, N. 26 at Barnegat, and 40 NE. at Sandy Hook. At noon Cautionary Signals were hoisted from Cape Lookout along the coast north to include Wood's Holl. Moving SE., by afternoon of the 5th the centre had passed off the New England coast,

at which time brisk to high NE. winds prevailed on the New Jersey and North Carolina coasts, with rain in connection with a small area of depression existing in the South Atlantic States. The Signals from Wood's Holl south to include Norfolk were lowered the afternoon of the 5th, and from Cape Henry south to include all displayed on the afternoon of the 6th. The pressure remained nearly stationary S. of the New England and E. of the Middle Atlantic States, with no change until the morning of the 7th. They were all justified, maximum velocities of 32 SW. at Wood's Holl and 32 NE. at Cape Henry and Cape Lookout being reported. The passage of this area was marked by the minimum temperatures generally for New England and the Middle Atlantic States and a considerable portion of the Lake region. A minimum temperature of 33° was reported from Sydney, C. B., the morning of the 6th, during the night of which date a sharp frost was reported from the Magdalen Island and a light frost 5th and 6th at Hector, N. Y.

No. III.—This area was central in northeastern Minnesota the morning of the 18th; Duluth barometer 0.25 above the normal. Moving thence nearly east, it skirted the northern edge of Lake Huron, and by the morning of the 19th had reached eastern Quebec, and that afternoon in lower St. Lawrence valley; Quebec barometer 0.31 abnormally high. Its direction then changed to nearly due south, and on the morning of the 20th it was central in Massachusetts; Albany barometer 0.30 and Boston 0.28 above the normal. It passed south that afternoon, and remained central over the Atlantic Ocean off the Middle Atlantic coast, with almost stationary pressure until the afternoon of the 21st. Its passage was marked by cool northerly winds and generally clear weather over the Lake region, New England and Middle Atlantic States. No signals were displayed. Several instances of brisk to high winds, ranging from SW. 27 at Eastport to NE. 32 at Cape Lookout, were reported from the 18th to the 21st and an easterly gale in the Bay of St. Lawrence.

No. IV.—This area traversed the British possessions north of the Lake region during the 23rd and 24th, causing fresh to brisk north to east winds—maximum, Sandusky 30 miles E., reported at midnight of the 24th—with generally clear weather south of the centre. On the morning of the 25th the pressure was central in lower St. Lawrence valley; Quebec barometer 0.23 above the normal—with clear weather and gentle N. to E. winds in New England, fresh to brisk easterly winds in the Middle Atlantic States. Signals were then ordered for the Jersey coast, and at noon, increasing winds with 27 miles S. at Kittyhawk being reported, signals were displayed on the Carolina coast, and in connection with advancing low area No. VII, remained displayed until the morning of the 27th. The signals were fully verified by south and southwest winds on the Carolina coast, ranging from S. 29 miles at Cape Henry to S. 35 at Macon, and on the Jersey coast from S. 28 at Atlantic City to SW. 37 at Sandy Hook. The high pressure moved rapidly from Quebec southeast, and on the afternoon of the 25th passed off the New England coast.

Areas of Low Barometer.—Upon chart No. I are shown the tracks of nine areas which have been sufficiently marked and extensive to enable their course to be accurately charted. A continuation of area No. IX described in the *June Review* is not charted, as central the morning of the 1st in Manitoba—Pembina barometer 0.32 below the normal—it had passed by afternoon beyond our stations. Its passage was marked the afternoon of the 30th of June, by a violent local storm at Bismarck, unroofing houses and wrecking a large steamboat, and from Fort Garry was reported a high northwest wind the morning of the 1st of July, and 1.45 inches rain-fall in eight hours.

No. I.—This area appears to have developed in California during the 1st, from the depression remaining from area No. IX described in the *June Review*. Moving east it was central in Colorado the morning of the 2nd, whence its course was northeastward during the day and central the morning of the 3rd in eastern Dakota, the depression increasing from maximum 0.18 below barometric normal at North Platte the morning of the 2nd to 0.36 below at St. Paul the morning of the 3rd. The passage of the area on the 2nd was marked by local storms of the most violent character. At Elkhorn, Dakota, a tornado, at 5:30 p. m., traveling in circular course from SW. to SE., totally destroyed three buildings, and injured one person. In Plymouth Co., at La Mars, Iowa, about 7 p. m. 2nd, violent storm, shaped like an hour-glass, destroying a number of buildings and killing two persons. In Goodhue Co., Minn., at Belle Creek, buildings demolished; whence traveling northeast through Vasa it demolished a church and orphanage, killing nine persons and injuring thirty others. At Lake Emily, five persons killed and many buildings destroyed. At Red Wing, very violent, damaging many buildings, and crossed the Mississippi river into Pierce Co., Wis., where many buildings were destroyed at Maiden Rock and Trenton. At Warren, flood followed by which four persons perished. St. Paul, Minn., on morning of 3rd reported 3.70 inches rain in preceding 8½ hours and 4.93 inches in preceding 15 hours. In Steele Co., Minn., a succession of violent thunderstorms occurred. At Yankton, Dakota, the barometer in seventeen hours fell abnormally 0.37 and at St. Paul 0.39. On the morning of 3rd the area moving rapidly eastward signals were displayed on Lake Michigan. Reports missing from the Northwest, cloudy weather, with brisk southerly winds, prevailing on Lakes Michigan and Huron. By afternoon the centre was over Lake Superior; Marquette barometer 0.33 below normal. Signals were then lowered, having been justified by velocities from NW. 27 miles at Escanaba to NE. 38 at Milwaukee, except at Alpena, where velocity of 24 miles was reported. At Sandusky W. 28 miles on the 2d, and at Marquette NW. 28 miles on the 3rd, were reported. The centre moved eastward through Ontario and on the morning of the 4th, was central in lower St. Lawrence valley; Quebec barometer 0.44 below the normal. At that time, brisk northerly winds, with cloudy weather, on the Lower Lakes, and gentle to brisk SW. winds, with partly cloudy weather in New England and the Middle Atlantic States, were reported. Signals were then displayed for Lake Ontario, the Carolina coast, at Newport and Wood's Holl. At the afternoon

report the storm had passed into the Gulf of St. Lawrence and the signals were lowered. The signals on Lake Ontario were not justified. The Carolina signals were all justified; maximum velocity at Cape Hatteras SW. 28. At Newport and Wood's Holl the signals were justified by SW. 25 and SW. 32, but were somewhat late at Wood's Holl, where SW. and W. winds from 26 to 28 miles had prevailed from the 2nd to morning of the 4th. By the afternoon of the 4th the storm-centre had passed into the Gulf of St. Lawrence; Sydney barometer 0.52 below the normal, followed by cloudy weather and rain in New England, with brisk westerly winds, a maximum velocity of W. 27 miles being reported during the afternoon from Boston.

No. II.—This area first appeared in the Valley of the Sacramento July 2nd, where its course during the 3rd, 4th and 5th was a little north of east through Idaho and Montana, and was in Dakota the morning of the 6th; Bismarck barometer 0.28 below the normal. At that report high easterly winds, with cloudy weather, prevailed in the Northwest, with heavy rain-falls, 1.33 inches in less than eight hours at Pembina. The course of the centre was thence northeast, and in the afternoon it was in eastern Manitoba—all reports from the Northwest missing. The abnormal barometric isobar of -0.20 included Dakota, Minnesota and parts of Iowa and Wisconsin. A terrific hail-storm that morning prevailed in Meeker and Kandiyohi counties, Minn., and during the afternoon violent thunder-storm at Madison, Wis., with hail large enough to kill yearlings, and 1.83 inches in seven hours. At La Crosse, Wis., severe thunder-storm, with 1.30 inches rain-fall in one and a half hours. Although the centre had passed into Manitoba, the trough in the Upper Mississippi valley changed but little from the afternoon of the 6th to the morning of the 7th, at which time the rain-fall at Madison was reported as 3.70 inches in twenty-four hours, and at La Crosse 4.70 inches for the same period. On the afternoon of the 6th fresh to brisk southerly winds, with cloudy weather and rain, prevailed on the Upper Lakes, with a maximum velocity of 41 miles, SW. reported from Milwaukee. At midnight a maximum velocity of 44 miles SW. was reported from Marquette. On the morning of the 7th reports from the Upper Mississippi valley and the Northwest were missing, and brisk southerly winds, with cloudy weather and light rains, were reported from the Lower Lakes, when signals for Lake Erie were ordered, which were lowered at midnight of the 7th, being justified, except at Port Huron and Buffalo, by winds ranging from SW. 28 at Sandusky and Toledo to S. 33 at Cleveland. At midnight of the 7th signals were displayed from Cape May northward along the Atlantic coast to include Eastport. By the morning of the 8th the area was probably central in northwestern Quebec. At that time Parry Sound barometer was 0.38 below the normal, and brisk S. and SW. winds were reported, with cloudy weather and rain, from New England and South Atlantic States to the Lake region. Velocities from 28 S. at Cape May to 33 SE. at Sandy Hook prevailed, while the brisk winds on the North Carolina coast, (maximum velocity S. 25 miles at Cape Henry,) were followed by signals from Cape Henry south to Macon. The area moving northeast all Signals were lowered on the Atlantic coast the afternoon of the 8th, having been justified, except at Cape Henry and Eastport, by velocities ranging from SW. 25 at Macon to S. 38 miles at Wood's Holl. The storm central in northeastern Quebec at midnight of the 8th changed its course from northeast to southeast, and on the morning of the 9th was central in lower St. Lawrence valley; Father Point barometer 0.38 below the normal. At that time fresh to brisk north winds, with clear weather, were reported from New England, and cloudy weather, with heavy rain and fresh winds, from the Canadian Maritime stations, except a velocity of S. 30 miles from Father Point. Central the afternoon of the 9th in New Brunswick and at midnight in Nova Scotia the area passed southeastward over the Atlantic Ocean. No high winds were reported on the morning of the 10th.

No. III.—This area appeared first in the Middle Plateau district on the 7th, and moving nearly east passed through Idaho and Wyoming on the 8th and 9th, and was central in Western Dakota the morning of the 10th; Yankton barometer 0.29 below the normal. At that time heavy rains were reported from Minnesota and Wisconsin, with cloudy weather and variable winds over the whole Lake region. Moving nearly east, the centre was in Minnesota at midnight of the 10th and over Lake Michigan the morning of the 11th, Milwaukee barometer 0.43 below the normal when brisk N. to W. winds prevailed over Lakes Superior and Michigan, and southerly winds with cloudy weather and no precipitation on the Lower Lakes, except a heavy rain fall of 2.06 inches reported for previous eight hours from Sandusky. Cautionary Signals were then ordered for Lakes Michigan, Huron and Erie. By the afternoon of the 11th it was central over Lake Ontario, which was covered by an average barometric pressure of 0.43 below the normal, while the abnormal isobar of -0.30 covered New England, Middle Atlantic States and the Lower Lakes. The Lake signals were then lowered, having been justified for Lake Erie, maxima velocities of N. 45 miles at Cleveland and N. 67 at Sandusky being reported. The signals for Lakes Michigan and Huron were not justified by reports yet received. Severe and destructive local storms occurred during the day in Canada, Ohio, Michigan, Pennsylvania and Maryland, which are mentioned under Local Storms. At this time cloudy weather and brisk southerly winds were reported from New England and the Middle Atlantic States, with a maximum velocity of 30 miles SW. wind at Cape Lookout. Cautionary Signals were then displayed for the New Jersey coast from Lewes to Sandy Hook. At midnight of the 11th the area was central in Connecticut; New York barometer 0.48 abnormally low. At this time the Signals from Lewes to Sandy Hook were lowered, having been fully justified by winds ranging in maximum velocity from SE. 26 miles at Barnegat to 30 S. at Cape May. Brisk to high SW. winds were, however, reported from the North Carolina coast, and a velocity of NW. 46 miles at Cape Henry. On the morning of the 12th the area was central off the New Jersey coast—Atlantic City barometer 0.47 below the normal—and brisk winds were reported, NE. in

New England, NW. on the Jersey coast and SW. on the North Carolina coast, with rainfall in past eight hours from New England to Ohio valley. The centre thence moved west of south, and in the afternoon of the 12th was in North Carolina; Wilmington barometer 0.36 below the normal. At noon, however, high northerly winds, of maximum velocities ranging from N. 30 at Cape May to N. 35 at Barnegat, had been reported and Cautionary Signals displayed from Cape Henry south to include Macon. These Signals were lowered that afternoon, having been fully justified by maxima velocities ranging from NE. 26 miles at Cape Henry to N. 35 at Macon. These signals were lowered somewhat soon, as the centre, moving southwestward, was central at midnight of the 12th on the South Carolina coast, and NE. winds, with maximum velocities from 26 to 32 miles, were reported from the North Carolina coast. The area moved slowly off the South Carolina coast during the 13th. This area produced the maximum temperatures of the month for the Upper Mississippi, Tennessee and Ohio valleys and the South Atlantic States, in the last of which sections the highest temperatures ever known were experienced, reaching 104° at Charleston and Augusta and 105° at Savannah on the 12th and 104° at Jacksonville on the 11th.

No. IV.—During the 10th the pressure fell from the Pacific coast to Utah and Western Montana, with cloudy and threatening weather and light rains on the coasts of Oregon and Washington Territory. 11th, pressure fell rapidly over Oregon, Washington Territory, Idaho and western Montana, reaching the minimum (29.53 and 29.51 or 0.50 and 0.48 below the normals respectively,) at Portland and Olympia at 4:35 p. m., and (29.50 or 0.30 below) at Virginia City at 11 p. m.; the observer at New Westminster, B. C., reported "at 6 p. m., barometer 29.43, wind WSW., heavy blue black clouds from W. moving rapidly—midnight, wind backed to S. and then SE. and blew a heavy gale in fierce gusts with very heavy rain until 9 a. m. 12th—nothing like this known here before in July;" about the same hour (6 p. m.) a "violent wind and rain-storm" occurred at Umatilla, Or.; and a "severe local storm also passed over Dayton, Columbia Co., Washington, Ty., which struck Pomeroy, 10 miles from Dayton ten minutes later." 12th, passed rapidly eastward over or to the north of Montana; light rains fell at the Rocky Mountain stations and in the Lower Missouri valley, and at 11 p. m. threatening weather was reported in the Red River of the North valley. It was followed on the Pacific coast by cold weather, the minimum temperature of the month (40°) being reported at Roseburg, while the maximum temperatures of the month were reported at several stations over the Eastern Slope of the Rocky Mountains: Cheyenne, 95°; Deadwood, 92°; Bismarck, 95°; Pembina, 90°; Pilot Point and Coleman, Tex., 107°. 13th, was probably central north of Lake Superior; a severe thunderstorm with heavy rain occurred at Duluth during the early morning, (5 to 10 a. m.) followed at noon by a brisk southwest wind, 28 miles at Duluth and SE. 31 at Milwaukee, for which signals were not ordered. High temperatures continued over the eastern section of the country and the following maxima of the month were recorded: Denver, 98°; North Platte, 99°; Henrietta, Tex., 105°; Graham, 109°; Concho, 108°. Its course from the 13th to the afternoon of the 14th was too far north of our stations to be accurately traced; but at the latter report it was central in Vermont, marked by little energy; Burlington barometer 0.13 below normal. Thence moving NE. at midnight it was central in Maine, and the morning of the 15th in New Brunswick, its progress marked by no high winds and light precipitation. No signals were ordered and no dangerous winds reported.

No. V was north of the Lake region, in Ontario, the morning of the 15th; Parry Sound barometer 0.11 below the normal. Moving nearly east, it was central in eastern Ontario during the afternoon and midnight. At the latter report clear weather and fresh westerly winds prevailed on the Lower Lakes and fresh southerly winds with partly cloudy weather and rain areas in New England. Severe local storms, with hail and heavy winds, prevailed in various parts of Ontario during the day. On the 16th, in the morning, it was in the Upper St. Lawrence valley; Quebec barometer 0.25 below the normal, with falling barometer and fresh S. to W. winds, and clear weather with very high temperature reported from New England. During the day it moved southeast, and in the afternoon was central in Maine; Burlington barometer 0.33 and Eastport barometer 0.30 below the normal. At this time fresh to brisk easterly winds with cloudy weather prevailed in the Lower St. Lawrence valley and variable winds, with violent thunderstorms in New England, with maxima velocities of 38 miles NW. at Boston and 40 NW. at Wood's Holl, and SW. winds from 26 to 28 miles from the North Carolina coast, with cloudy weather and rain. During the day the maximum temperatures for the month occurred at most stations from Virginia to Massachusetts, which were followed over New York and New England by a series of violent thunderstorms and cooler weather. The numerous cases of sunstroke will be found noted under Temperature, and the violent storms, by which many lives were lost and great damage done to property, under Local Storms. By midnight of the 16th the centre had reached eastern Maine; Eastport barometer 0.38 below the normal, with fresh S. to W. winds, cloudy weather and heavy rainfall in New England. Maximum velocities, from several stations, ranging from 25 to 32 miles, were reported from the New Jersey and North Carolina coasts. On the 17th the area, in Nova Scotia in the morning and near Cape Breton at the afternoon report, passed northeastward over the Atlantic Ocean, attended by gales and terrific squalls, the depression having increased to 0.50 below the barometric normal at Halifax in the morning and at Sydney in the afternoon.

No. VI.—This area, appearing in western Nebraska the afternoon of the 21st and moving nearly east, passed through Nebraska and Iowa with little energy, reaching Wisconsin the afternoon of the 22nd; Milwaukee barometer 0.17 below the normal; by midnight it had reached Lake Huron, with cloudy weather and heavy rains on the Lower Lakes, fresh SW. to SE. winds, but one station, Sandusky, reporting a maximum velocity of SW. 25 miles on the Lakes, and Cape May S. 30 on the Atlantic coast. On the 23d it was central at the

morning report in Ontario; Kingston barometer 0.32 below the normal; brisk SW. winds and cloudy weather in the Middle Atlantic States and New England, accompanied in the latter by heavy rains. In the afternoon central in Maine, brisk SW. winds were reported from Carolina to Massachusetts, with a maximum velocity of 28 SW. at Cape Lookout. The course of the area was northeast, and by midnight it had passed into the Gulf of St. Lawrence. No signals were displayed during the passage of this area.

No. VII.—This area, whose presence was first shown by the barometers in the Northwest on the 24th was central on the morning of the 25th in eastern Manitoba; Pembina barometer 0.33 below the normal generally cloudy weather, with southerly to westerly winds and light local rains, being reported from the Upper Lakes and Northwest; moving southeasterly, with increased pressure, it was central over Lake Superior, midnight of that date. During the day southerly to westerly winds and cloudy weather had prevailed, with moderate rain-fall over the Lake region and Northwest. On the 26th, in the morning, the depression was central over Lake Michigan; Escanaba, barometer 0.26 below the normal; in the afternoon in eastern Michigan. At midnight it reached southern Ontario. During the day, rainy weather, with brisk to high southerly winds, on the New Jersey and North Carolina coasts, and rainy weather, with fresh easterly winds, in New England, were reported, while clear weather and fresh southerly winds prevailed over the Lake region. Signals displayed in connection with high area No. IV on the 25th from Macon north to Sandy Hook inclusive were continued up, and during the afternoon of the 26th signals were displayed at New York. On the morning of the 27th, the pressure passed off the New England coast; Portland barometer 0.28 below the normal. At this time fresh to high northerly winds, 30 miles NE. at Eastport Me., with cloudy weather and heavy rain-falls, were reported from New England, and fresh to brisk west to southwest winds from the New Jersey and North Carolina Coasts. All the Signals on the Atlantic coast were then lowered, having been fully justified, as shown in connection with high area No. IV.

No. VIII.—This area appears to have sprung up from the remains of area No. VII, and at midnight of the 27th was central north of Lake Superior, at which time fresh westerly winds, with heavy rain-falls, were reported from that Lake. On the morning of the 28th the central pressure had reached the eastern part of Lake Superior; Marquette barometer 0.22 below the normal. Moving eastward through Ontario at midnight it was central at Quebec, and on the morning of the 29th passed into the Gulf of St. Lawrence. The passage of the area was marked by little energy, and no dangerous winds in connection therewith were reported.

No. IX.—This area was central in western Manitoba on the afternoon of the 30th, and by midnight had reached central Dakota; Bismarck and Pembina barometers, respectively, 0.29 and 0.31 below the normal. Its course during the 31st was a little east of south while its movement was sluggish, and its pressure increasing being 0.18 below the normal at Yankton on midnight of the 31st. No dangerous winds were reported in connection with this area.

INTERNATIONAL METEOROLOGY.

WORLD WEATHER CHARTS—Meteorological Charts of the Northern Hemisphere.—It has been the plan of these charts that they should be based upon observations taken simultaneously by day and at night on land and at sea. The observations to be those of the barometer, thermometer, weather, etc., had everywhere on the globe at the same fixed instant of physical time—That is for example observations so arranged that those at Washington, St. Petersburg, Constantinople, etc., are taken not at the same hours of local or clock time at those cities—for they would not then be taken at the same moment, but so arranged that the readers or observers are actually at the instruments at once, all reading and recording at one and at the same moment the readings and records are being made at every other station, and so for all places. The atmosphere over any extent of the earth can thus be viewed as a whole, and at once before any movements in it are possible. The resulting charts give a true synopsis—in effect a photograph of the atmosphere and its conditions at the instant. Such observations are known as *SIMULTANEOUS OBSERVATIONS*. They are characteristic of the work of this office. They were for the first time practically employed by it for purposes of prediction in 1870. Simultaneous observations as thus described are, upon the invitation of the United States, widely taken throughout the world. They are collated at this office, printed and issued daily, forming “The International Bulletin of Meteorological Observations taken simultaneously.” The International co-operation, embraces observations taken by almost every civilized power north of the equator, and observations taken at sea.

Four charts, based upon International Meteorological Observations, taken simultaneously, are issued with this *Review*. These charts have been specially prepared. The subject of the preparation of such World Charts is referred to in the annual report of the Chief Signal Officer for the year 1878 and in preceding reports. They embrace within their limits the Northern Hemisphere.

Chart No. IV is based on the *Bulletin of International Meteorological Observations*, taken at 7:35 a. m., Washington mean time, under date of December 26, 1878, and exhibits in graphic form the barometric pressure and temperatures over the Northern Hemisphere so had for that date and hour. Lines of equal barometric pressure and equal temperature are charted and their values are expressed in French and English measures. Extended areas of high pressures and marked barometric depressions are respectively indicated as High, Higher, Highest and Low, Lower, Lowest. This map presents the data of the bulletin for the day charted for study. It is a map of the Northern Hemisphere and is charted daily.

Chart No. V, is based on the daily *International Weather Charts and Daily Bulletin of International Meteorological Observations* taken simultaneously for December, 1877, and shows the mean isobars, mean isotherms, mean velocity and prevailing direction of the wind at 7:35 a. m., Washington mean time, (0:43 p. m., Greenwich mean time,) for that month, as deduced from the simultaneous observations received at this office. The values of the lines are given in French and English measures. Isolated means, when barometric, are expressed in English inches, and when thermometric, in degrees Fahrenheit. The chart is one of the Northern Hemisphere.

Chart No. VI, is based on the *Daily International Weather Charts and Daily Bulletin of International Meteorological Observations for December, 1877*, and shows the movements of the *Centres of Low Barometer*, as charted from day to day, for that month, and also the lines of equal precipitation (rain and melted snow) as deduced from U. S. Signal Service observations and those of co-operating international observers. Arabic numerals show the location of the centre of Low Barometer at 7:35 a. m., Washington mean time, (0:43 p. m., Greenwich mean time,) on the day of the month having a similar number. Lines of equal rain-fall are given in both French and English measures. Isolated rain-falls, without the continuous lines, are expressed in English inches. The chart is one of the Northern Hemisphere.

Chart No. VII, is based on International Simultaneous Observations received to date, on United States Signal Service observations and on marine and other reports, received from voluntary observers. It shows the movements of the centres of the most definitely marked areas of Low Barometer of recent date. The tracks in black have been charted in previous Reviews in connection with the storms of the United States, and the tracks as subsequently determined are charted in red. The subject of Ocean Storm Tracks and the connection of them with storm-tracks on land is expressly considered in the preparation of these charts. A table of the wind velocities accompanying the storms, both on the European and American coasts, is printed upon the chart. The chart is one of the Northern Hemisphere.

In order to satisfy the many inquiries concerning the condition, scope and progress of the labor connected with the international simultaneous observations, there is herewith published an extract from the Annual Report of the Chief Signal Officer to the Secretary of War, dated Nov. 1st, 1878, wherein are sufficiently set forth the origin of the work, its plan, the co-operation it has received from distinguished co-laborers, its progress, scope, and purposes, as follows:

"The proposition adopted at the congress of persons charged with meteorological duties, assembled at Vienna in 1873, and to the effect that it is desirable, with a view to their exchange, that at least one uniform observation, of such character as to be suited for the preparation of synoptic charts, be taken and recorded daily and simultaneously at as many stations as practicable throughout the world, has continued to have practical effect.

By authority of the War Department, and with the courteous co-operation of scientific men and chiefs of meteorological services representing the different countries, a record of observations taken daily, simultaneously with the observations taken throughout the United States and the adjacent islands, is exchanged semi-monthly. These reports are to cover the territorial extent of Algiers, Australasia, Austria, Belgium, Central America, China, Denmark, France, Germany, Great Britain, Greece, Greenland, Iceland, India, Italy, Japan, Mexico, Morocco, The Netherlands, Norway, Portugal, Russia, Spain, Sweden, Switzerland, Tunis, Turkey, British North America, the United States, the Azores, Malta, Mauritius, Sandwich Islands, South Africa, South America and West Indies.

On July 1, 1875, the daily issue of a printed bulletin, exhibiting these international simultaneous reports, was commenced at this office and has been since maintained. A copy of this bulletin is furnished each co-operating observer. The results to be had from the reports thus collated are considered as to be of especial importance. The bulletin combines, for the first time of which there is record, the labors of the nations in a work of this kind for their mutual benefit. There is needed only the assistance to be had from the naval forces of the different powers (that of the navies of the United States and of Portugal being, as heretofore related, already given to extend the plan of report upon the seas) to bring more fully within the scope of study observations practically extending around the northern hemisphere. This end is to a great extent already attained.

In this connection the office has to acknowledge the cordial and valuable co-operation of the meteorological services of the different countries, represented as follows:

Algiers, by General Teissier, Commandant Supérieur du Génie; Austria, by Prof. Dr. Julius Hann, Director of the Imperial Royal and Central Meteorological Institute at Vienna; Belgium, by J. C. Houzeau, Director of the Royal Observatory at Brussels; Costa Rica, by Señor Federico Maison, Director of the Central Office of Statistics and Meteorology; Denmark, by Captain N. Hoffmeyer, Director of the Royal Danish Meteorological Institute at Copenhagen; France, by U. J. LeVerrier, Director of the Paris Observatory, Prof. E. Mascart, Director of the Central Meteorological Bureau of France, and the respective observers; Germany, by Prof. Dr. Geo. Neumayer, Director of the German Naval Observatory, Hamburg; Great Britain, by Robert H. Scott, Esq., F. R. S., Secretary of the Meteorological Council, London, Alexander Buchan, M. A., F. R. S. E., Secretary of the Scottish Meteorological Society, Edinburgh, and the respective observers; Greece, by Prof. Dr. J. F. Julius Schmidt, Director of the Royal Observatory at Athens; India, by H. F. Blanford, Meteorological Reporter to the Government of India; Italy, by the Minister of Agriculture, Industry and Commerce, and the respective observers; Japan, by the Imperial Meteorological Observatory, and the Imperial University of Tokyo; Mexico, by Señor Mariano Barceña, Director of the Central Meteorological Observatory in the City of Mexico, and the respective

observers; Netherlands, by Prof. Buys Ballot, Director of the Royal Meteorological Institute of the Netherlands at Utrecht; Norway, by Prof. H. Mohn, Director of the Royal Norwegian Meteorological Institute at Christiania; Portugal, by J. C. de Brito Capello, Director of the Meteorological Observatory of the Infante Don Luiz at Lisbon; Russia, by Prof. H. Wild, Director of the Imperial Central Physical Observatory of Russia at St. Petersburg; Spain, by Antonio Aguilar, Director of the Royal Observatory at Madrid, and the respective observers; Sweden, by Prof. R. Rubenson, Director of the Royal Swedish Meteorological Institute at Stockholm, and Dr. H. H. Hildebrandsson, Chief of the Meteorological Division of the Upsala Observatory; Switzerland, by Prof. R. Wolf, Director of the Observatory at Zurich, and Prof. E. Plantamour, Director of the Observatory at Geneva; Turkey, by A. Coumbary, Effendi, Director of the Central Observatory at Constantinople, and Prof. C. V. A. Van Dyck, Superintendent of the Lee Observatory at Beirut; Australasia, by Francis Abbott, Director of the Meteorological Observatory, Hobart Town, Tasmania, and R. L. J. Ellery, Director of the Meteorological Observatory at Melbourne, Victoria, Australia; Canada, by Prof. G. T. Kingston, Director of the Magnetic Observatory at Toronto, and Superintendent of the Meteorological Office of the Dominion of Canada, and the respective observers; United States Navy, by the Navy Department, through Rear-Admiral Daniel Ammen, and Commodore W. D. Whiting, U. S. N., Chiefs of the Bureau of Navigation; and by individual observers at other points.

The office has to regret the death, since the date of the last annual report, of four co-laborers in the work, Urbain Jean Joseph Le Verrier, Director of the Paris Observatory, Prof. Ernest Quetelet, Director of the Royal Observatory at Brussels, Prof. Edward Heis, of Münster, and Prof. Pietro Angelo Secchi, of Rome.

A number of observations taken on vessels at sea to complement the synchronous reports of the service, and at the request of the department, have been received on the form provided for the purpose. Their utility is evident in the study of storms approaching our coasts or which endanger vessels from our ports.

The coöperation of the Navy of the United States in the taking of observations, simultaneously with the system adopted at this office, wherever naval vessels of the United States may be, as assured by the general order of the Secretary of the Navy, dated December 25th, 1876, has largely increased the data of this class. This coöperation has been skillfully rendered by the Navy Department and the United States Navy, through the Chief of the Bureau of Navigation.

The people of the United States are thus the first nation whose Army and Navy co-operate, as all armies and navies should, under official orders, in the taking of simultaneous observations, wherever the forces may be.

In view of the existence of the system of simultaneous reports to be made at sea by the vessels of the naval and commercial marines of the United States and other nations, and to provide for its extension, carefully tested barometers of the best make have, since the date of the last annual report, been prepared and located, as standards, at the ports of New York and San Francisco.

These barometers have been publicly located to afford means for comparison of the ships' barometers of the shipping of all nations. The instruments, while carefully guarded, are easily accessible. Public notice is given of the location, and a Sergeant of the Signal Corps attends daily to give information and to take charge of any ship's barometer which may be brought for comparison.

The standard barometer for the use of shipping on the Atlantic Ocean is located at the Maritime Exchange, in New York City; the standard barometer for the use of shipping on the Pacific Ocean is located at the Merchants' Exchange, in the city of San Francisco.

* The officers of the Signal Service at the different cities and ports of the United States and upon the sea-coast offer every facility and aid in their power to the vessels of any nation.

With the plans for charting now adopted at this office, and with the reports now received here, it appears that the meteoric changes occurring over a great portion of the continents north of the equator can be charted with an accuracy sufficient to permit careful and valuable study. This charting, to be of the best attainable value, must be supplemented from the records of observations had on the seas. A ship at sea becomes one of the best of stations for a simultaneous system. The value of the record is enhanced by the change of the ship's location occurring within each of the twenty-four hours. There is no sea-going vessel but which carries human life, and each ought to carry, by compulsion, if need be, meteorological instruments. The smallest craft, in caring for its own safety, may use them enough to add to the value of the most extensive record. There is no nation without interest in the work proposed to be based upon exchanged simultaneous reports, and none has hereto hesitated, when the subject has been properly presented, to aid in a duty which, so easily done as to require very little effort on the part of any one person, has for its object a good to mankind. The work cannot, from its nature, be for the selfish good of any section.

A number of the great steamship companies, foreign and domestic, operating the principal commercial sea-routes, have promised and will give their powerful influence and aid.

The office has the co-operation of the Pacific Mail Steamship Company, through its agents, Williams, Blanchard & Co.; the White Star Line, through its agents, Ismay Imrie & Co., Liverpool, and R. J. Curtis, New York; the Occidental and Oriental Steamship Company, through its president, George H. Bradbury; the North German Lloyd, through its agents, A. Schumacher & Co.; the American Steamship Co., through its president, H. D. Welsh; the Red Star Line, through its president, James A. Wright; and the Allan Line, through its agents, A. Schumacher & Co.

The United States bear, in the cases of all maritime observers co-operating in this system, all expenses for forms, postages, etc., when so desired, and not infrequently, and, when necessary, loan the required instruments.

The number of observations made daily on separate vessels at sea is one hundred.

Even if predictions are not directly practicable, research has already gone far enough to indicate the paths through which to learn what sequences will be found on our own western coasts, consequent on conditions reported as existing on or near the eastern coast of Asia or on the Pacific Ocean.

Similar studies will have reference to our own southern and eastern coasts and to the western coasts of the European Continent. The time cannot be far distant when vessels leaving any Atlantic port may be informed whether any notable disturbances exists at sea, and where it is likely to threaten the voyage.

The establishment of permanent ocean stations in lines traversing the oceans over or near the telephic cables; and in telegraphic communication with either continent, is not considered impracticable and has been referred to in a preceding report.

There is reason to hope that a progress has been made which will eliminate from the study of practical international meteorology some of the difficulties hitherto encountered.

There are grounds to hope also, that the atmospheric conditions and changes of condition can be charted with sufficient accuracy over any extent of the earth's surface. If the hope has fruition meteorological barriers will, as against study, practically cease to exist.

While the stations are crowded in some localities, each is useful—each serving to check the work of the other, and each aiding to close the gaps the failure of other stations might sometimes cause. The work is not likely to be abandoned by those in the different countries who have taken part in establishing it, and who share its benefits. If it served no other purpose than to maintain, as it does, the pleasant co-operation of those charged with the meteorological duties of the different countries, it would be of value. It is hoped that by systems of observations thus extensive, generalizations may be had to permit the announcement of meteoric changes for periods longer in advance than have been hitherto practicable.

The average number of daily simultaneous observations now made in foreign countries is two hundred and ninety-three. The total number of stations on land and on vessels at sea from which reports are entered in the bulletin regularly is five hundred and fifty-seven. The co-operation of the different nations, secured by this plan of exchange, as above described, renders the additional cost to the United States, of the grand system of reports it makes possible, but little more than that of the cost of the preparation, paper, and binding of the International Bulletin and the accompanying charts, a cost which would have to be met in great part for the proper preservation of the records themselves, even if the bulletins were not distributed.

The Chief Signal Officer is gratified to announce in his report that the work of the collection of the reports of International Simultaneous Observations, carried on in foreign countries in coöperation with the United States, as well as within the Territories of the United States and upon the seas, thus above referred to, has, in the year just passed, so far progressed as to have attained one principal result for which it was set on foot. On July 1st, 1878, it became possible, for the first time in the history of this office, to commence the issue, on that date, of a daily international weather map, charted daily and issued daily, each chart based upon the data appearing upon the International Bulletin of Simultaneous Reports of similar date. The charting extends around the world, and embraces for its area the whole Northern Hemisphere.

The daily issue of a chart of this kind, thus daily issued for the first time by the United States, is without a precedent in history. It exhibits the coöperation, for a single purpose, of the civilized powers of the world north of the equator.

The studies of such charts make possible the improvement which will come as the work progresses, and the area of the chart is better filled with reports of observations carefully elaborated, are fully appreciated by scientific men.

The questions as to the translations of storms from continent to continent, and of the times and directions they may take in such movements; the movement of areas of high and of low barometer; the conditions of temperature, pressure and wind-direction existing around the earth at a fixed instant of time, permitting thus the effects of day and night to be contrasted; the distribution and amount of rainfall, and other studies, many and valuable, only suggested by this enumeration, may be by such studies settled. It seems not impossible that in the future questions of climatology, and perhaps others bearing upon the prediction of weather changes far in advance of the time at which these changes may happen, or questions of the character of coming seasons even, may be answered by the researches these charts will make practicable.

The very great aid and material furnished in this elaborated form gives to the search for generalization, or for data in the support of theories, was referred to in the last annual report. In frequent cases little more than collation is necessary.

As a means of better combining the work and the interests of the several nations; of certainly securing that co-operation at sea which will enable the lines of the charting to be drawn as fully and as well over oceans as over continents; and which will give the world ultimately a knowledge as practical of the movement of areas of disturbance in the midst of the seas as is now had of such movements on some continents, the undertaking is of much importance.

It is an advantage of the charting draughted from simultaneous reports that studies by normals, not possible in any other way, can be made. The normal pressure, temperature, &c., arrived at from observa-

tions taken at any one place, at the same and a fixed instant of time every day, become established as to that place and time with accuracy.

Many causes of error are eliminated.

The inter-comparison of these normals with the normals taken at other places simultaneously with the first and under the similar condition that the normals to be found by those places are to be from observations taken at those places at a fixed time and on every day, gives results reliable, and differing from those to be had by the use of normal readings arrived at in any other manner. Normals for the year, for the season, and for the month may be determined by such procedure. The comparison of such normals will show in the case of abnormal changes in any district or section, for any season, whether and how they are compensated by compensating variations elsewhere. There are interesting studies as to what sequences there may be to follow such atmospheric variations occurring over any region or country—either in that region or country or elsewhere—and how and where the compensating variations occur, and with what concomitants or sequences of meteoric changes.

There is the hope to gain in this way, or by investigations which such study will suggest, information to benefit the commercial and agricultural interests of the world.

There is the further hope that as it is more fully realized by the different peoples, how close in the future the practice of such investigations draws, each member of the family of nations will find its own interests in labors of this description, and draw more closely the bonds and join with energy in a work which has so begun to connect them. The undertaking, world-wide in extent, is capable of rendering a world-wide benefit."

Maps based upon a single simultaneous observation, taken daily, demonstrate what may be expected when more frequent observations are attainable, and the daily period of twenty-four hours may be exactly divided by the intervals at which such observations are taken.

It is by the study of charts of the character of those herewith described and referred to, the practical solutions of the great questions of Ocean and Continental Meteorology, and possibly some prevision of seasons, may be hoped to be arrived at.

On chart No. VII are shown the probable tracks of storm-centres over the oceans, deduced from data received at this office up to August 6th, and in the upper right-hand corner will be found an index to the same. In the upper left-hand corner is a table giving the approximate direction and probable maximum velocity of the wind (in miles per hour and meters per second) attending area No. III. Below is a brief notice of the areas, and also of some storms over the Southern Hemisphere:

North Atlantic Ocean.—No. I probably moved northeastward over the British Channel, during the night of June 2nd, thence to the North Sea and Gulf of Bothnia, and southward over Russia to the Black Sea. No. II may possibly be a continuation of area of low barometer No. XIV, shown on chart No. I, of the *May Review*; it passed southeastward over Newfoundland on June 1st, and on the 2nd and 3rd rainy weather and variable winds prevailed thence to 40° W.; on the 4th and 5th a depression probably existed about as shown on chart, although reports from the Azores are not yet to hand. No. III is a continuation of low area No. III, of chart I, *June Review*; it passed over Newfoundland (barometer at St. Johns about 29.04) on the 14th and crossed the ocean, attended by rainy weather and high seas and followed by westerly gales and high NW. seas well; it passed northeastward over the British Isles on the 21st with very unsettled weather and moderate to fresh southerly gales. No. IV is a continuation of low area No. IV, of *June Review*; on the 18th it was south of Newfoundland, but cannot at present be traced farther eastward. No. V probably originated during June 11th off Newfoundland, after which it moved eastward. No. VI is a continuation of low area No. V, of the *June Review*; it probably passed eastward north of Newfoundland on the 23rd, developed increased energy about 50° N., 30° W. on the 26th, and northeastward at some distance to the northwestward of the British Isles on the 27th and 28th. No. VII probably followed a path somewhat as shown on chart from the 22nd to the 25th. *South Atlantic Ocean.*—Ship *Altcar*, at Queenstown, June 22nd, from San Francisco reports:—"From lat. 30° S., long. 123° to *Cape Horn*, which was passed April 16th, 1879, had continuous gales from NE. by E. to S. and heavy cross-seas; lost sails, stove boats, bulwarks, &c.; decks constantly flooded—from April 22nd constant gales, culminating on May 1st and 2nd in a terrific gale and heavy sea, during which decks were constantly under water." At Montevideo, May 23rd, 1879, N. gale; 24th, SSE. strong gale; June 24th and 25th, schooner *Syra* driven ashore and lost during storm. *North Pacific Ocean.*—Three tracks are shown on chart:—No. I produced strong SW. winds and moderate gales, with heavy rains, at Yokohama on April 24th and 25th, and brisk to high winds at Unalaska on the 27th and 28th. No. II produced heavy rainfall (2.75 inches in one hour) at Yokohama from 7 to 8 p. m. of May 7th. No. III probably passed eastward at some distance north of Yokohama on May 12th and 13th, and produced SE. to W. gales at Unalaska on the 14th and 15th. *South Pacific Ocean.*—April 11th to 14th 1879, from 34° S., 166° E. to 34° S., 151° E. ESE. to SW. gales, heavy seas and bad weather; at Sydney, N. S. Wales, May 3rd, SSW. gale, squally; 25th, 34° S., 170° E., NE. gale, rough sea, rain; 26th, 36° S., 175° E., ENE., strong gale, squally. *Indian Ocean.*—March 8th, 1879, 12° 41' S., 113° 23' E., heavy squall from WSW. 11th, 14° S., 112° E., "had tail of a hurricane from NW., hove to for five hours." April 20th, 31° S., 39° E., severe gale from NW. to SW. May 4th, 24° S., 54° E., hurricane. *Bay of Bengal.*—During the latter part of May the monsoon rains set in along the coast and the track of an area of low pressure which on May 20th was probably central over the bay is given on chart No. VII.

TEMPERATURE OF THE AIR.

The isothermal lines on chart No. II show the general distribution of the temperature of the air for the month. By reference to the table of average temperatures given on the same chart it will be seen that it has been below the average in the Pacific States, over the Western Plateau and in the Lower Canadian Provinces. In the East Gulf and Atlantic States it has been about normal for the whole month, the high temperatures experienced during the middle of the month having been compensated by the moderate temperatures attending the continued rains of the latter part. In the South Atlantic States the means for Jacksonville, Savannah, Charleston, Augusta and Lynchburg show a slight excess, which is, however, compensated for by those for the North Carolina coast. Elsewhere the temperature of the present month has been higher than the average, especially so from the Upper Lake region to the Rio Grande valley. The following data, relative to sunstrokes, generally extracted from newspaper reports, together with the notes on drought given under "Precipitation," will serve to give a fair idea of the effects of the high temperatures: On the 8th, at St. Louis, Mo., there were seven prostrations; 9th, eight prostrations and one fatal; 10th, warmest day of season, 100°, "two degrees higher than last summer," six prostrations, two fatal; Milwaukee, Wis., several prostrations, 1 fatal; Charleston, S. C., 101°, "two degrees higher than for last twenty years;" Nashville, Tenn., one fatal. 11th, New York City, 92°, several prostrations, none fatal; St. Louis, Mo., six prostrations, one fatal; Cincinnati, Ohio, two fatal; Memphis, Tenn., one fatal; Charleston, S. C., "very hot," fifteen fatal. 12th, Charleston, "111° at 2 p. m., highest temperature for over 100 years," over one hundred prostrations, thirty fatal; Milwaukee, Wis., several prostrations; Memphis, Tenn., three prostrations. 13th, Portland, Mich., one fatal. 14th, St. Louis, Mo., one fatal; Fort Wayne, Ind., three prostrations, none fatal; Memphis, Tenn., three prostrations, one fatal. 15th, New York City, seventeen prostrations, one fatal; Atlanta, Ga., "heat almost intolerable for past ten days, sunstrokes have been reported in almost every city in the state;" Detroit, Mich., "heat intense," one fatal; Cincinnati, Ohio, several prostrations, one fatal; Vincennes, Ind., one prostration; Fort Wayne, Ind., two fatal; Osbourne, Ohio, one probably fatal; Paris, Ky., several prostrations; Delaware, O., one prostration; Akron, two fatal; St. Louis, Mo., three prostrations, Sandusky, Ohio, one prostration; Nashville, Tennessee, two "sunstrokes;" 16th, Philadelphia, Pa., "heat very great," one or two fatal; Pittsburgh, Pa., "hottest day this year," three prostrations; Kittanning, Pa., one fatal; Cincinnati, O., four prostrations, one fatal; St. Louis, Mo., six prostrations, one fatal; Baltimore, Md., seven prostrations, two fatal; New York City, N. Y., nineteen prostrations, four fatal; Boston, Mass., "two days of intense heat;" Chattanooga, Tenn., "one case of sunstroke." 31st, Cincinnati, O., one prostration.

Maximum and Minimum Temperatures.—Upon charting the maximum temperatures of the month, it is found that the line of 90° runs through Maine, the Lower Lake region, southern Michigan, northward over Lake Michigan, thence over Lake Superior to Manitoba, and afterwards includes western Montana; the line of 100° includes Virginia, the South Atlantic and East Gulf States and Tennessee, except at the stations along the Gulf and North Carolina coasts—the highest maximum (105°) over this region occurred at Savannah on the afternoon of the 12th; a second 100° line runs northward from the Rio Grande along the coast of Texas, through Arkansas and Missouri to Illinois, westward to Kansas and southwestward through southern New Mexico; thence northwestward, including within its limits the southwestern half of Arizona, the interior of California and portions of Nevada and Idaho. Areas of 105° and above comprise part of Indian Territory, the whole interior of Texas, southern half of Arizona and the San Joaquin and Sacramento valleys. Extreme temperatures are reported as follows:—Yuma, 115°; Burkes, 114°, at these stations maximum temperatures above 100° daily, ranging at Yuma from 101° on the 2nd, and at Burke's from 102° on the 2nd, to 115° and 114° respectively on the 26th; Red Bluff, Cal., Phoenix and Florence, Ariz., 110°; Fort Gibson, Ind. Ty., 109°; and Denison and Griffin, Tex., 108°.

Upon charting the minimum temperatures it is found that the line of 70° and above includes only southern Texas and the stations bordering the Gulf of Mexico. The line of 60° and above comprises within its limits the South Atlantic States, Tennessee and Ohio valley, Virginia, Maryland, Indian Territory, Missouri, and Kansas. Below 50° are the northern parts of New England and Upper Lakes, the Northwest, Oregon, elevated stations and the Rocky Mountain Slope as far south as Santa Fé. The lowest temperature reported from a Signal Service station, except Pike's Peak 30° and Mt. Washington 31°, was at Campo 30°. The following list refers to the States and Territories in detail:

Minimum and Maximum Temperatures are, respectively, as follows: *Maine*—47° at Eastport to 93° at Portland. *Vermont*—42° at *Woodstock to 90° at Burlington and 94° at *West Charlotte. *Massachusetts*—43° at *Waltham and 50° at Boston to 94° at Boston and 99° at *Somerset. *Rhode Island*—51° at *Fort Adams to 86° at Newport and 88° at *Fort Adams. *Connecticut*—51° at New London and New Haven to 93° at New Haven. *New York*—46° at *Cooperstown and 52° at Albany to 96° at Sandy Hook and 100° at *Starkey. *New Jersey*—46° at Vineland and 53° at Barnegat to 96° at Barnegat and 100° at *Acton and *Linden. *Pennsylvania*—50° at *Newcastle and *Wellsborough and 56° at Pittsburgh to 99° at Pittsburgh and 102° at *Milton. *Delaware*—66° to 94° at *Dover. *Maryland*—52° at *Woodstock to 99° at Baltimore and 102° at *Fort McHenry. *District of Columbia*—59° to 102° at Washington. *Virginia*—57° at Fort Whipple to 102° at Norfolk and 104° *Dover Mines. *West Virginia*—57° to 98° at Morgantown. *North Carolina*—56° at *White Sulphur Springs, 63° at Charlotte, Wilmington and Smithville to 103° at Wilmington and 107° at *Weldon. *South Carolina*—71° to 105° at Charleston. *Georgia*—61° at

*Thomasville and 65° at Atlanta to 104° at Augusta and 105° at *Thomasville. *Florida*—68° to 104° at Jacksonville. *Alabama*—67° at *Wilsonville and 71° at Mobile to 101° at Montgomery and *Wilsonville. *Mississippi*—68° at Vicksburg to 98° at Vicksburg and 102° at *Brookhaven. *Louisiana*—67° to 100° at Shreveport. *Texas*—59° at Fort Davis to 109° at Graham. *Ohio*—53° at *Westerville to 98° at Cincinnati and 100° at *Jacksonburg. *Kentucky*—63° to 98° at Louisville. *Tennessee*—64° at Knoxville to 101° at Chattanooga and Nashville. *Arkansas*—66° at *Mount Ida and 67° at Little Rock to 100° at *Mount Ida and Little Rock. *Michigan*—48° at Alpena to 93° at Marquette and 96° at *Niles and *Thornville. *Indiana*—55° at *Spiceland and 58° at Indianapolis to 96° at Indianapolis and 100° at *Veray. *Illinois*—58° to 101° at Springfield. *Missouri*—55° at *Kansas City and 62° at St. Louis to 100° at St. Louis. *Kansas*—61° at Leavenworth to 97° at Leavenworth and 105° at *Independence and *Wellington. *Wisconsin*—50° at *Neillsville and 53° at Milwaukee to 93° at Madison. *Iowa*—55° at Des Moines and *Muscatine to 98° at Keokuk and 102° at *Boonesboro. *Nebraska*—53° to 99° at North Platte. *Indian Territory*—67° at Fort Sill and Fort Gibson to 109° at Fort Gibson. *Minnesota*—49° at Duluth to 92° at St. Paul. *Dakota*—44° at Deadwood to 98° at Yankton and 102° at *Olivet. *Colorado*—33° at *Summit to 98° at *Hermosa and Denver. *New Mexico*—47° at Santa Fe to 104° at La Mesilla. *Wyoming*—38° at *Fort Fred Steele and 42° at Cheyenne to 95 at Cheyenne and 101° at *Fort Fred Steele. *Montana*—43° to 86° at Virginia City. *Utah*—55° at Salt Lake City to 97° at Salt Lake City and 99° at *Kanab. *Nevada*—39° at Winnemucca to 97° at Winnemucca and 102° at *Fort McDermitt. *Arizona*—41° at Fort Apache to 116° at Florence, Yuma and *Texas Hill. *Idaho*—43° to 100° at Boise City. *California*—45° at *Calistoga and 51° at San Francisco to 110° at Red Bluff and 119° at *Mammoth Tank. *Oregon*—40° to 96° at Roseburg.

*Those marked with a * are voluntary reports.

Ranges of Temperature at Signal Service Stations.—The monthly ranges will appear from an examination of the minima and maxima just given. Greatest daily ranges vary in New England from 20° at Wood's Holl and Mount Washington to 32° at Thatcher's Island; Middle Atlantic States, 16° at Cape May to 34° at Norfolk; South Atlantic States, 14° at Cape Lookout to 29° at Augusta; Gulf States, 14° at Key West to 28° at Shreveport and Corsicana; Ohio valley and Tennessee, 19° at Cairo to 32° at Pittsburgh; Lower Lake region, 24° at Erie to 31° at Oswego; Upper Lake region, 23° at Chicago, Grand Haven and Milwaukee to 33° at Marquette; the Northwest, 23° at Davenport, La Crosse and Omaha to 36° at Pembina and Fort Stevenson; Eastern Slope, 27° at Eagle Pass and San Antonio to 45° at Pilot Point; Rocky Mountain stations, 30° at Pike's Peak to 42° at Cheyenne; Western Plateau, 32° at Salt Lake City to 45° at Winnemucca; California, 17° at San Diego to 45° at Visalia; Oregon, 30° at Portland to 35° at Roseburg.

Frost.—1st, at Springfield, Mass., Niles, Starkey, N. Y.; 5th, at Scott Valley, Cal., heavy, killing vegetation; Fall River, on low ground, and Westport, Mass., 6th; sharp frost in Magdalen Islands, Gulf of St. Lawrence; Summit, Col., nearly every night during month.

Ice.—5th, at Yreka, Cal.

PRECIPITATION.

General Notes on Precipitation of Month.—The general distribution of rain-fall for the month is illustrated as accurately as possible on chart No. III by returns from about 500 stations. In the lower left-hand corner of the chart will be found a table giving the average precipitation for July by districts. In general, the rain-fall for the first half of the month was deficient; serious droughts being reported in Texas, Nevada, Utah and the Middle and South Atlantic States and Tennessee. The extensive precipitation of the latter part of the month somewhat remedied the condition of Tennessee and the Middle and South Atlantic States but has not materially improved the condition of the other States, where numerous droughts were reported as prevailing at the end of the month. The excess of precipitation has been greatest in Oregon, Minnesota, Upper Missouri valley and Eastern Gulf States. Marked deficiencies are reported from the Western Gulf States and Ohio valley, and trifling ones from the Middle Atlantic States, Lower Missouri valley and California. Moderate amounts, in excess, have fallen in other districts. The month is remarkable for the number of sudden and heavy rains reported.

Specially Heavy Rains.—1st, Leavenworth, Kan., 1.51 inches in 8 hours. 2nd, Okalooska, La., 2.05 in 3 hours 30 minutes; St. Paul, Minn., 4.93 in 8 hours 30 minutes. 3rd, Fort Snelling, Minn., 6.60 in 25 hours; Mobile, Ala., 1.60 in 2 hours; Alpena, Mich., 1.47 in 2 hours. 4th, New Orleans, La., 1.37 in 3 hours 40 minutes. 6th, Chicago, Ill., 1.15 in 1 hour 45 minutes. 7th, Madison, Wis., 3.70 in 24 hours, of which 1.18 fell in 1 hour 45 minutes; La Crosse, Wis., 5.15 in 30 hours; Dubuque, Iowa, 2.85 in 8 hours; Logansport, Ind., 3.50 in 30 minutes; at Mound City, Mo., 10 inches is "reported" during a storm of about 36 hours; no authority given. 8th, Hinsdale, Ill., 3.75; Columbus, Ohio, 0.96 in 2 hours. 9th, Davenport, Iowa, 3.11 in 10 hours; Dubuque, Iowa, 2.52 in 6 hours 30 minutes; Monticello, Iowa, 5.60 in 24 hours; Sidney, Neb., 2.18 in 2 hours 45 minutes. 10th, Breckenridge, Minn., 1.59 in 3 hours; Duluth, Minn., 1.32 in 4 hours; Urbana, Ohio, nearly 2.00 in 25 minutes; Hudson, Ohio, 3.00 on 10th and 11th; Cleveland, Ohio, 3.86 in 24 hours, of which 3.30 fell in 7 hours 35 minutes; greatest amount in same time for 25 years. 11th, Sandusky, Ohio, 2.30 in 9 hours; Toledo, Ohio, 0.73 in 1 hour 15 minutes; Norwalk, Ohio, 1.04 in 1 hour; Cleveland, Ohio, 3.30 in 6 hours 35 minutes, of which 1.24 fell in 1 hour 5 min. 12th, New London, Conn., 1.44 in 8 hours; New Haven, 3.00 in 8 hours. 14th, Smithville, N. C., 1.65 in 8 hours; Thomasville, Ga., 2.18 inches in 6 hours. 15th, Yankton, Dak., 3.11 in 3 hours 55 minutes. 16th, New London, Conn., 1.73 in 5 hours 40 minutes; New Haven, 1.69 in 2 hours; Newport, R. I., 1.20 in 6 hours 20

minutes; North Platte, 1.36 in 2 hours; Fort Barrancas, Fla., 3.09; Fort Independence, 1.24 in 15 minutes; Amherst, Mass., 2.00 in 20 minutes; Dodge City, Kan., 1.94 in 5 hours. 19th, Fort Gibson, I. T., 1.16 in 4 hours 22 minutes; New Orleans, La., 1.28 in 1 hour 35 minutes; Mobile, 1.43 in 2 hours 30 minutes; Anna, Ill., 2.06 in 2 hours 45 minutes. 21st, North Platte, 1.57 in 3 hours 30 minutes; Fort Barrancas, Fla., 1.80 and 2.43 on 23rd; Litchfield, Penn., 1 inch in 40 minutes; Columbus, Ohio, 0.67 in 30 minutes. 24th, Brookhaven, Miss., 1.90 in.; Mobile, Ala., 1.80 in 1 hour; Smithville, N. C., 4.98 in less than 14 hours; Nashville, Tenn., 5.04 in 24 hours of which 3.30 fell in 4 hours 50 minutes. 26th, Ft. Preble, Me., 3.02 in.; Flushing, N. Y., 1 in hour; Trenton, N. J., 2.09 in 3 to 4 hours; Washington, D. C., 1.73 in 1 hour 15 minutes; Morgantown, 1.50 in 1 hour; Wilmington, N. C., 1.35 in 6 hours; Holmesville, Penn., 3.50 in 1 hour 15 minutes, "heaviest ever known." 27th, Portland, Me., 1.80 in about 6 hours; Pittsburgh, Penn., 1.05 in 1 hour 15 minutes; Fort Barrancas, Fla., 2.37 in. 28th, Shreveport, 1.21 in 5 hours; Ft. Wallace, Kan., 1.60 in 1 hour; Fayetteville, N. C., 3.50 in. followed by 6.50 on the 29th. 30th, Charlotte, N. C., 4.25 in 40 minutes; Fort Monroe, 2.18 in. 31st, New Orleans, La., 1.31 in 7 hours 30 minutes; Cape Henry, Va., 4.25 in less than 24 hours.

Largest Monthly Rain-falls.—Fort Barrancas, Fla., 18.32 inches; Fayetteville, N. C., 17.50; Mobile, Ala., 11.17; Duluth, Minn., 10.42; Mount Washington, N. H., 10.23; Smithville, N. C., 10.21; Sterling, Ill., 9.90; St. Marks, Fla., 9.82; Fort Snelling, Minn., 9.71; New Haven, Conn., 9.50; St. Joseph, Mo., 9.55; St. Paul, Minn., 9.32; Sidney, Neb., 8.72; Monticello, Iowa, 8.66; Charlotte, N. C., 8.64; Mt. Vernon, Iowa, 8.50; Nashville, Tenn., 8.47; North Platte, Neb., 8.47; Forsyth, Ga., 8.23; Fort McPherson, Neb., 8.14; Pittsburgh, Pa., 7.78.

Smallest Monthly Rain-falls.—Over an extensive area, embracing the largest parts of California, Nevada, Utah and portion of the Rio Grande valley, and included within lines marked 0.00 on Chart No. III, numerous reports show that no precipitation occurred. A trace or 0.01 inch was reported at San Francisco, Cal., Winnemucca, Nev., Burkes, Ariz., Boise City, Idaho, Fort McDermit, Austin, Nev., and Brackettville and Uvalde, Texas; 0.02 at Willows, Cal.; 0.04 at Red Bluff, Cal.; Fort McKavett, and Edinburg, Tex.; 0.05 at St. George, Utah; 0.07 at Salt Lake City, Utah; 0.10 at St. Mary's Wyo; 0.12 at San Antonio, and 0.14 at Eagle Pass, Tex.

Rainy Days.—The number of days on which rain or snow has fallen varies as follows: New England, 9 to 19; Middle Atlantic States, 8 to 14; South Atlantic States, 6 to 17; Gulf States, 6 to 22; Western Texas, 1 to 5; Tennessee and the Ohio valley, 6 to 14; Lower Lakes, 7 to 16; Upper Lakes, 6 to 21; Upper Mississippi valley, 7 to 15; Missouri valley, 10 to 15; Red River of the North valley, 6 to 18; Eastern Rocky Mountain Slope, 3 to 14; Rocky Mountains, 5 to 18; Pike's Peak, 20; Western Plateau, 1 to 6; California, 0 to 2; Oregon, 5 to 8.

Cloudy Days.—The number of days on which cloudiness averaged eight-tenths is as follows: New England, 5 to 17; Middle Atlantic States, 4 to 9; South Atlantic States, 4 to 12; Gulf States, 2 to 15; Ohio valley and Tennessee, 4 to 7; Lower Lakes, 3 to 12; Upper Lakes, 1 to 12; Upper Mississippi valley, 2 to 8; Missouri valley, 3 to 8; Red River of the North valley, 5 to 6; Eastern Rocky Mountain Slope, 0 to 11; Rocky Mountain stations, 0 to 7; Western Plateau, 0 to 2; California, 0 to 3; Oregon, 3 to 10.

Hail.—The largest numbers of hail-storms reported from a single station are twelve from Pike's Peak, and seven from Fort Wallace, Kan. The only occasion on which hail seems to have been general to any extent, appears to have been in connection with severe local storms of the 16th, when hail was reported from Central New York eastward, to include the greater part of Massachusetts and parts of Rhode Island and Connecticut. The largest hail in Ulster Co., N. Y., where "ice fell in chunks" and at Lanesborough, Mass., where stones seven inches in circumference fell, occurred in connection with these storms. Near Madison, Wis., on 6th, "size of man's fist, killing yearling pigs, &c." No such storms have been reported from either the Gulf States, South Atlantic States, Tennessee, Southeastern Rocky Mountain slope, or Pacific coast. In the Plateau districts it fell only at Fort Douglass, Utah and El Paso, Texas. Only six stations report more than one storm.

Snow.—Red Bluff, Cal., reports a light snow-fall on one part of the coast range on the 31st. A few flakes fell at Portland, Me., on the 4th, followed by a shower of rain, temperature above 50°. 4th, on Salmon Mountain, Cal., elevation 6,200 feet.

Droughts.—The most extensive and serious droughts of the month are reported from Maryland, Virginia, Texas, Utah, and Nevada. In Maryland and Virginia droughts covering the greatest part of the latter and a considerable portion of the former State were reported to have seriously injured the crops, and in Virginia it was said to have been worst known in twenty years. It terminated on the 26th, since which time copious rains have generally fallen. In the central part of Texas, from the Rio Grande to Red rivers, serious droughts have prevailed during the entire month which have nearly ruined the crops and killed much stock. In the section of country lying between the Rio Grande and Colorado rivers the suffering has been the greatest; all the small streams have gone dry and water holes dried up. In consequence, large numbers of cattle are reported dying in the valley of the Rio Grande, and the crops are utter failures. At Pioche, Nev. and Deep Creek, Utah, it was yet severe at the end of the month.

Floods and Waterspouts.—9th, heavy mountain floods reported near Socorro, N. M.; severe local flood at Monticello, Iowa. On the 15th, heavy thunder-storm, with waterspout near Buffalo station, 30 miles south of Denver, Col.; several large buildings carried away, and the bed of the railroad was seriously

damaged by washouts: very heavy rain caused flood at Yankton, carrying away railway bridges and tracks; 16th, local flood; doing considerable damage to low building; and railroad tracks at Toledo, O.; 19th, cloud-burst ten miles south of Yreka, Cal.; 20th, serious washouts on Union Pacific Railroad reported near North Platte; 21st, Nora Springs, Iowa, waterspout; 26th, waterspout on divide north of Colorado Springs, carried away bridges and caused serious washouts on railway; serious flood near Pittsburgh, swept away twenty-five buildings, (near Petrolia, Pa.,) several bridges and many miles of railway track; seven inches of rain reported from Irwin, Pa., estimated damage, \$300,000.

RELATIVE HUMIDITY.

The percentages of mean Relative Humidity for the month range as follows: New England, 60 to 81; Middle Atlantic States, 60 to 80; South Atlantic States, 63 to 82; Gulf States, 57 to 79; Ohio valley and Tennessee, 57 to 70; Lower Lakes, 64 to 70; Upper Lakes, 67 to 72; Upper Mississippi valley, 61 to 73; Lower Missouri valley, 67 to 71; Red River of the North valley, 72 to 75; Eastern Rocky Mountain Slope, 21 to 81; Rocky Mountain stations, 38 to 50; Western Plateau, 13 to 34; California, 33 to 78; Oregon, 61 to 65; Arizona, 27 to 43. *High stations* report the following averages, not corrected for altitude: Mt. Washington, 86.4; Pike's Peak, 50.7.

WINDS.

The prevailing winds, at the Signal Corps stations, are shown by the arrows flying with the wind on chart No. II. The *maxima velocities* per hour have been given in the descriptions of movements of areas of low pressure.

Total Movements of the Air.—The following are the *largest* monthly movements in miles recorded at the Signal Corps stations:—Mount Washington, 20,152 miles; Cape Lookout, 13,200; Cape Hatteras, 11,129; Kittyhawk, 10,573; Dodge City, 9,725; Wood's Holl, 9,407; Pike's Peak, 9,239; Indianola, 8,949; Sandy Hook, 8,713; Smithville, 8,694; Cape May, 8,268; Breckenridge, 7,586. The *smallest* movements are:—La Mesilla, 1,593 miles; Tucson, 1,806; Nashville, 1,911; Silver City, 1,941; Florence, 2,039; Lynchburg, 2,199; Indianapolis, 2,634; Augusta, Ga., 2,755; Olympia, 2,785; Morgantown, 2,810; Cairo, 2,886.

Local Storms.—During the month local storms have been numerous and occasionally quite severe. Those notable for *heavy rain* or *hail* will be found under the respective headings. The following is a summary of those accompanied by high or destructive winds: On the 2nd severe local storms occurred in Dakota, Minnesota, Iowa and Wisconsin, preceding low pressure area No. I, as follows: At Elkhorn, D. T., 5.30 p. m., tornado from SW. to SE. in circular course, destroying buildings, &c; the storm in Goodhue Co., Minn., Wednesday night and Thursday morning (2nd—3rd) seemed to start four miles beyond Vasa, the place of greatest destruction, and traveled toward the SW., nine persons killed and thirty injured; at Lake Emily five persons injured, considerable stock killed, granary lifted from foundation and carried 80 feet distant—storm crossed the Mississippi river at Red Wing into Pierce Co., Wis.; at Warrenton a "house was carried away, and four persons who were in it were drowned while attempting to escape, the house being flooded several feet deep;" persons were killed by lightning at Winnebago and Mountain Lake, and "every town in S. and E. part of Wisconsin suffered severely;" a "terrible" wind storm is also reported in northern part of Plymouth Co., Iowa, between 6 and 7 p. m., destroying houses and killing two men; the storm cloud was observed from Lemars, and is described as "having the appearance of an hour-glass, after which it assumed a straight column, and then seemed to break into fragments and drift away; it was in sight about half an hour. On the 6th "violent" NW. wind storm at Logansport, Ind. On the 10th and 11th severe storms accompanied low area No. II in Michigan, Ontario, Ohio, Pennsylvania, New York and Maryland as follows: 11th, Thornville, Lapeer Co., Mich., "hurricane," many buildings demolished, and in adjoining town two persons killed; at Port Huron "heaviest wind ever recorded here; numerous buildings unrooted and trees blown down, all lying from W. to E.; Sardinia, Ontario, noon, terrific storm, "apparently from across the river, in the direction of Port Huron, lasting 15 minutes, doing much damage to buildings and crops;" Sandusky, max. vel. of wind for 10 minutes, 72 miles per hour; Logan Co., Ohio, perfect hurricane in southwestern part of county, buildings damaged and stock killed, track seven miles wide and ten long, one man killed by lightning; Maumee valley, much damage to houses and trees; Erie Co., destructive storm at 3 p. m., lasting five minutes, reported to have alternately touched the ground and then to leave it for a while, general direction of storm towards the southeast, fallen trees generally lying in that direction, but some lying toward the NW.—an observer to the north of the storm states "that a funnel-shaped cloud descended to the ground, rested a moment, and then bounded off; its general appearance was a heavy bank of clouds, reaching to the surface of the ground;" in the Juniata valley, Pa., a storm doing much damage; most destructive at Mifflin, one person killed; at Lewistown buildings were blown down. On the 13th, heavy storms are reported to have visited Wrightsville and Hawkinsville, Ga., demolishing buildings, &c. On the 14th, during passage of low area No. IV at Niagara Falls, N. Y., "severe local storm, injuring buildings and trees," and at Wells' River, Vt., 5:45 p. m., "violent hail-storm and tornado" lasting fifteen minutes. On the 15th, accompanying low area No. V, severe storms in various parts of Ontario during afternoon, doing great damage to buildings and crops; Montreal, Can., night, severe thunder-storm, one person killed; Binghampton, N. Y., violent storm, one person killed, also one person killed at Skaneateles Falls by lightning. On the 16th, accompany-

ing same depression, very severe storms occurred over New York and New England, which were most destructive in a belt of country including the Mohawk and upper Hudson valleys, Massachusetts and Connecticut. They appear to have commenced in the Mohawk valley, about 1 p. m., where "a violent hurricane," seemingly about fifteen miles wide, passed over Herkimer, Fuller, Montgomery, Schenectady, Albany (2 p. m.) and Rensselaer counties, devastating orchards and leveling grain crops; a "violent storm" commenced at Coxsackie, Greene county, at 2:30 p. m.; Kingston and Saugerties, Ulster county, 4 p. m., "tornado," crops ruined, barns demolished, ice fell in large chunks." In Connecticut, at Shelton, "heavy storm," two men killed and two injured by lightning; off Long Island, boat capsized and two men drowned. *Massachusetts*—Pittsfield, 2:30 p. m., "tornado from west, three persons killed and four injured, buildings unroofed and blown down, storm took a course from NW. to SE., following along the valley, track not over sixty rods wide, in which hundreds of trees were leveled and buildings demolished;" Lanesboro', immense hail-stones, seven inches in circumference, great damage to crops, one person killed; West Stockbridge, one person killed; Springfield, 3:15 p. m., heavy storm; Northampton, 3 p. m., terrible storm, buildings and trees demolished, fearful wind, followed by heavy rain; Fitchburg, 3:35, "tornado, lasting three minutes," much damage to buildings and trees; Boston and vicinity, 4:17 p. m., severe wind and hail-storm, houses unroofed and one man killed; at Hull, captain of schooner washed overboard and drowned; off Baker's Island, sloop capsized and all on board drowned; off Salem, boy washed overboard and drowned; at Paddock's Island, man drowned; at Dover, town hall demolished and one man killed; at Brookline, church and town hall badly damaged; on Bird's Island flats, yacht capsized and six persons drowned; off Scituate, two boats capsized and three persons drowned; at Newton, trees uprooted and houses badly damaged; South Braintree, houses demolished and two persons injured; Lawrence, Essex county, storm began at 4 p. m., NW. gale for fifteen minutes. Taunton, Bristol co., 5:30 p. m., storm lasting five minutes, followed by two hours severe NW. gale. Nantasket, Norfolk co., "hurricane struck here at 5:30 p. m.," buildings demolished and six persons injured; near Governor's Island, two yachts capsized and five persons were drowned. In all thirty persons were drowned on that day in and around Massachusetts bay. Woods Holl, "tornado" or squall from 5 to 5:30 p. m. *Rhode Island*—Newport, between 5 and 6 p. m. "terrible storm of wind, rain and hail." Off Montauk Point, L. I., schooner Annie and Millard struck by lightning during heavy thunder-shower during Wednesday night. Schooner Agnes parted chains in Hamstead Harbor, L. I. Schooner Harriet Lewis, parted chains in Dutch Island Harbor, and several vessels lost sails and topmasts in Long Island Sound. On the 17th terrific thunder-storms, with heavy rains were reported in northeastern part of Texas, near Jefferson two horses were killed by lightning, and at Kildare a house was struck and one person killed; Chattanooga, Tenn., heavy storm, houses blown down; Portsmouth, Va., one person killed by lightning. On the 18th, off Point aux Trembles, 21 miles from Quebec, shortly before 9 p. m., yacht capsized and eight persons drowned. On the 23rd, accompanying low-area No. VI., at Smith Falls, Ontario, terrific thunder-storm, one person killed; Oakland, Ky., destructive wind-storm over northern section of county. On the 20th, accompanying low area No. VII., at Pittsburgh, Pa., a very violent storm of wind, with heavy rains, producing floods in the Youghiogheny, Monongahela and Alleghany valleys; at Philadelphia, Pa., heavy storm, houses unroofed. On the 28th, at Ft. Wallace, Kansas, a "violent NW. wind," and at McKinney, Tex., evening, "tornado" from the N., demolishing a church. 29th, Corsicana, Tex., "tornado" from west to east. 30th, Syracuse co., N. Y., "tornado" in southwestern part of county at 3 p. m., track three miles wide and ten miles long, lasting twenty minutes, déluge of water, crops much damaged.

VERIFICATIONS.

Indications.—The detailed comparison of the tri-daily weather indications for June with the telegraphic reports for the succeeding twenty-four hours, shows the general percentage of omissions to be 1.41 per cent, and of verifications to be 85.1 per cent. The percentages for the four elements have been, Weather, 97.3; Direction of the Wind, 87.0; Temperature, 82.4; Barometer, 87.3. The percentages of verifications by geographical districts have been: New England, 83.9; Middle States, 89.1; South Atlantic States, 82.3; East Gulf States, 80.8; West Gulf States, 82.5; Lower Lake region, 87.7; Upper Lake region, 86.3; Tennessee and the Ohio valley, 82.4; Upper Mississippi valley, 87.6; Lower Missouri valley, 85.0; Northern Pacific coast region, 91.7; Central Pacific coast region, 100; Southern Pacific coast region, 100. Of the 3,813 predictions that have been made, 149, or 3.91 per cent, are considered to have entirely failed; 116, or 3.04 per cent, were one-fourth verified; 423, or 11.09 per cent, were one-half verified; 457, or 11.99 per cent, were three-fourths verified; 2,614, or 68.55 per cent, were fully verified, so far as can be judged from the tri-daily weather maps.

Cautionary Signals.—98 Cautionary Signals were displayed during the month, of which 82, or 83.7 per cent., were justified. No Cautionary Off-shore Signals were displayed. The above does not include signals ordered at 47 display stations where the velocity is only estimated and not measured.

NAVIGATION.

Stage of Water in Rivers.—In the table on the right-hand side of chart No. III are given the highest and lowest readings of the Signal Corps river gauges for the month, with the dates. With one exception (Omaha from the 1st to the 4th) the rivers at the Signal Corps stations have not reached the danger line during the month. The Red River at Shreveport and the Missouri at Yankton, Omaha and Leavenworth have continued to fall slowly throughout. The Mississippi has fluctuated considerably but continued in a good

navigable state throughout. The Ohio at Pittsburgh continued low (between 1 foot 0 inches and 2 ft. 6 in.) from the 1st to the 12th, when it rose to 4 ft. 8 in. by the afternoon of the 13th, it then gradually fell to 0 ft. 7 in. on the 23d, (lowest of the month) but rose to 7 feet 6 in. (highest of month) on the 27th; at Cincinnati and Louisville the river continued quite low, and without much change, throughout month. The Cumberland at Nashville, the Tennessee at Chattanooga, and the Monongahela at Morgantown, remained low throughout month, except the flood in latter on the 26th, which is noted under its appropriate heading. The Savannah continued below 4½ ft., except on the 19th and 20th, when it rose to 5 ft. 9 in., and on the 30th, when it rose to 9 ft. 6 in. The observer at Fayetteville, N. C., reported the Cape Fear river lower this season than at any time for the past ten years, the water at one time being so low that steamers could not get within nine miles of the city. The heavy rains during latter part of month caused a rise of about 15 feet. The observer at New Westminster, B. C., reported the Frazier river very high on the 25th, when it was 11 ft. 1 in. above low water.

TEMPERATURE OF WATER.

The *temperatures of water*, as observed in rivers and harbors, with average depth at which the observations were taken, are given on chart No. II. The observations at San Francisco were interrupted from the 19th to the 31st on account of breakage of thermometer.

ATMOSPHERIC ELECTRICITY.

Thunder-storms.—Thunder-storms have occurred in too large numbers during the month to allow of their being enumerated in detail. An examination of the storms, after being charted, shows that the greatest average number prevailed in the Middle Rocky Mountain slope, where from five stations an average of eight storms is reported. The Middle Atlantic and Lower Missouri valley and Lower Lakes average five, while New England, Upper Missouri valley, Upper Lakes and Eastern Gulf range from an average of four to four-and-a-half. Very few of these storms were reported from the Western Gulf, the Plateau districts and the Northwest, and none are reported from the Pacific coast.

Auroras.—The most extensive aurora of the month occurred on the 24th, being reported from New England as far south as Westborough, Mass., New York and several points in Dakota. Cloudy weather from Lake Erie to Lake Superior, occurring at that time, prevented observations in those districts. Its appearance and disappearance must have been nearly simultaneous from New England to Dakota, it being noted at 10 p. m. in both sections, and disappeared only at dawn. At Burlington, Vt., it was reported to have an arch of emerald green, with a few very brilliant streamers; its color was noticeably green at both Burlington and East port, and no rose spots seen. Mt. Washington observer, however, reported it as pale yellow, with streamers of deeper hue. At Buffalo its color was faint white. An aurora is reported from Milton, and Wills borough, Penn., on the 25th. On the 16th at Vevay, Ind., maximum brilliancy at 11:45 p. m.; on the 17th at Vevay and New Corydon, Ind., and Mt. Solon, Va.; on the 19th at New Corydon, Ind., at 10 p. m., and at Monticello, Iowa.

Magnetic Variation.—Prof. F. Hess reports the variation of the magnetic needle near Pagosa Springs, Col., July 2nd, as 14° 24' east, and on the 18th, near the Blanco river, Col., 14° 32'.

Atmospheric Electricity Interfering with Telegraphic Communication at Santa Fe, N. M., from the 7th to the 11th, and from the 18th, excepting the 21st, daily to the 28th inclusive; 10th, violent electrical storm on the summit of Pikes Peak, causing hair to stand out; for a considerable time buzzing noises emitted from all metallic substances; 12th, at Sloop Point, N. C.

OPTICAL PHENOMENA.

Solar halos.—Solar halos are reported in very considerable numbers from New England, the Lower Lakes, Ohio valley, and Upper Mississippi; but three are reported from the South Atlantic States, three in the Gulf States and one in the Northwest. Elsewhere none prevailed or have not been deemed worthy of report. A remarkable solar halo, a report of which was received too late for the June REVIEW, occurred on June 4th, at Port Blakely, Wash. Ter. The sun was surrounded by four distinctly marked rings, the two inner, which were perfectly round, displayed rain-bow colors, the third oval, and the fourth round in form, were white. A huge circle, also of rain-bow hues, passing through the sun's centre, intersected the rings described. A mock sun of blinding brilliancy appeared at the intersection of this outside circle with the lower half of the oval ring. The phenomenon continued for more than an hour.

Lunar halos.—These were reported in considerable numbers, especially in the sections south of 38° north and east of 100° west, where, however, only eight solar halos were reported. But two were reported west of the hundredth meridian, one at San Diego, and one at Santa Fé, and but four in the entire Lake region and Northwest.

MISCELLANEOUS PHENOMENA.

Polar Bands.—10th, at Tabor, Ia.; 7th, 11th, 16th, 27th, at Gardner, Me.; Cape Vincent, N. Y., on 24th; Jacksonsburg, O., on the 12th.

Prairie Fires.—Near Mason, Tex., on 16th, and in Virginia previous to the 24th.

Zodiacal Light.—Lynchburg, 14th, 16th, 18th, 21st.

Mirage.—Breckenridge, Minn., on the 20th; Olivet, Dak., on the 27th.

Pollen in air on 7th and 11th at Breckenridge, Minn.

Sand Storm on the 26th at Visalia, Cal.

Distant Lightning on the 23rd, at Visalia, Cal.

Cotton worm first seen on 31st, at Okalouska, La.

Grasshoppers 31st at Bismarek, doing much damage; Salt Lake City, disappeared near the end of the month; 29th, North Platte, locusts flying north, none alighted; Ringgold, Ohio, grasshoppers injuring tobacco from 12th to 19th; Kansas City, Mo., present during the month but did little damage.

Earthquakes, 26th, Cairo, Ill., at 11.45 a. m. lasting three seconds, motion from north to south; also felt at Mound City, Ill.

Sunsets—the characteristics of the sky at sunset, as indicative of fair or foul weather, for the succeeding twenty-four hours, have been observed at all Signal Corps Stations. Reports from 135 stations show, 4,164 observations to have been made, of which 37 were reported doubtful; of the remainder, 3,389 or 82.1 per cent were followed by the expected weather.

Sun Spots.—The following record of observations, made by D. P. Todd, Assistant, has been forwarded by Prof. S. Newcomb, U. S. Navy, Superintendent Nautical Almanac, Washington, D. C.:

DATE— JULY, 1879.	No. of new—		Disappeared by solar rotation.		Reappeared by solar rotation.		Total number visible.		REMARKS.
	Groups	Spots.	Groups	Spots.	Groups	Spots.	Groups	Spots.	
1st, 3 p. m.	1	1	0	0	1	1	2	4	Faculae. Faculae.
2nd, 3 p. m.	0	0	0	0	0	0	2	4	
3d, 3 p. m.	0	0	0	0	0	0	2	3	
7th, 3 p. m.	0	0	0	0	0	0	0	0	
9th, 3 p. m.	0	0	0	0	0	0	0	0	
10th, 2 p. m.	1	5	0	0	0	0	1	5	
11th, 2 p. m.	0	0	0	0	0	0	1	4	
12th, 3 p. m.	0	0	0	0	0	0	1	4	
14th, 3 p. m.	0	0	0	0	0	0	1	1	
15th, 2 p. m.	0	1	0	0	0	0	1	2	
16th, 2 p. m.	0	0	0	0	0	0	1	1	Faculae.
17th, 3 p. m.	0	0	1	1	0	0	0	0	Faculae.

Observations were also made on the 18th, 19th, 22nd to 24th, 26th and 28th at 2 p. m., and 21st at 3 p. m., but no spots seen. Mr. Wm. Dawson, observing at Spiceland, Ind., reports, the 1st, 29 spots in one group (the same that was near centre of S. E. quadrant on the 27th ult.), 1 spot and prominent faculae at E. edge; 2d, 14 spots—4 very prominent—in large group, 2 or 3 spots at E. side of sun; 3rd, 15 spots—3 very prominent—in large group, 2 spots in E. quadrant; 5th, 1 spot of large group very near west edge, two spots in the other group a few degrees N.E. of centre; 10th, 14 spots, one group, about half way from east edge to centre; 11th, 20 spots, one group; 12th, 14 spots, one group, near centre, one spot quite large, with very prominent penumbra; 13th, 8 spots, one group, the large spot, near 8,000 miles long and about half as wide, penumbra fading; 14th, 15 spots, one group; 15th, 8 spots, one group; 16th, 10 spots, one group; 17th, 4 spots, one group, near west edge; 18th, no spots, large faculae where the group was; 28th, 7 spots, one group a few degrees from S.E. limb; 29th, 4 spots, one group; observations were made, but no spots observed from the 6th to the 9th, 20th to the 27th, and on 30th and 31st. Mr. David Trowbridge, observing at Waterbury, N. Y., reports, 1st, 2 spots; 3rd, 1 spot near west margin; 5th, spot disappeared by solar rotation; 13th, group of at least 2 large and 1 small spots near centre; 14th, 1 large spot; on the 10th, 18th, 20th, 24th, 29th and 31st no spots were observed; Mr. F. Hess, of Ft. Dodge, Iowa, observing "in the San Juan valley, Col., reports 1st, 8 spots in two groups; 2nd, one large and two small spots; 12th, one large and one small spot." Prof. G. Hinrichs, in the Bulletin of the Iowa Weather Service, reports "a group of spots visible about the middle of the month." Observations were made throughout the month at Ft. Whipple, Va., but no spots seen. Mr. H. D. Govey, North Lewisburg, Ohio, reports "on the 14th, at 7 a. m., local time, one spot quite large and two-thirds across the sun and near his equator."

PUBLISHED BY ORDER OF THE SECRETARY OF WAR.

Albert J. Myer

Brig. Gen. (Bvt. Assg^d.) Chief Signal Officer, U. S. A.

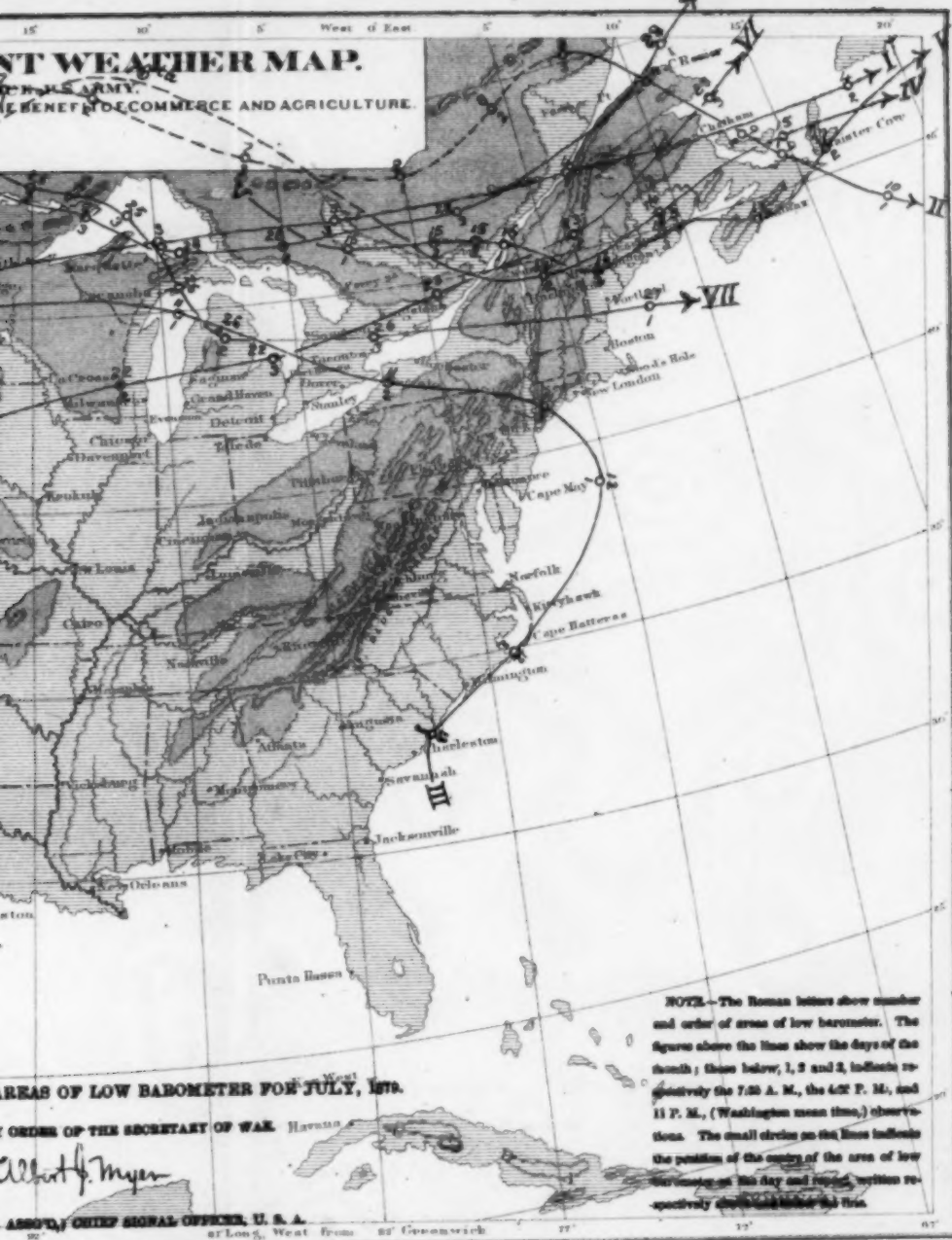
Copy furnished for



No. I.

WEATHER MAP.

FOR THE ARMY.
FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.



AREAS OF LOW BAROMETER FOR JULY, 1879.

BY ORDER OF THE SECRETARY OF WAR.

Wm. H. Meyer

ASST. CHIEF SIGNAL OFFICER, U. S. A.

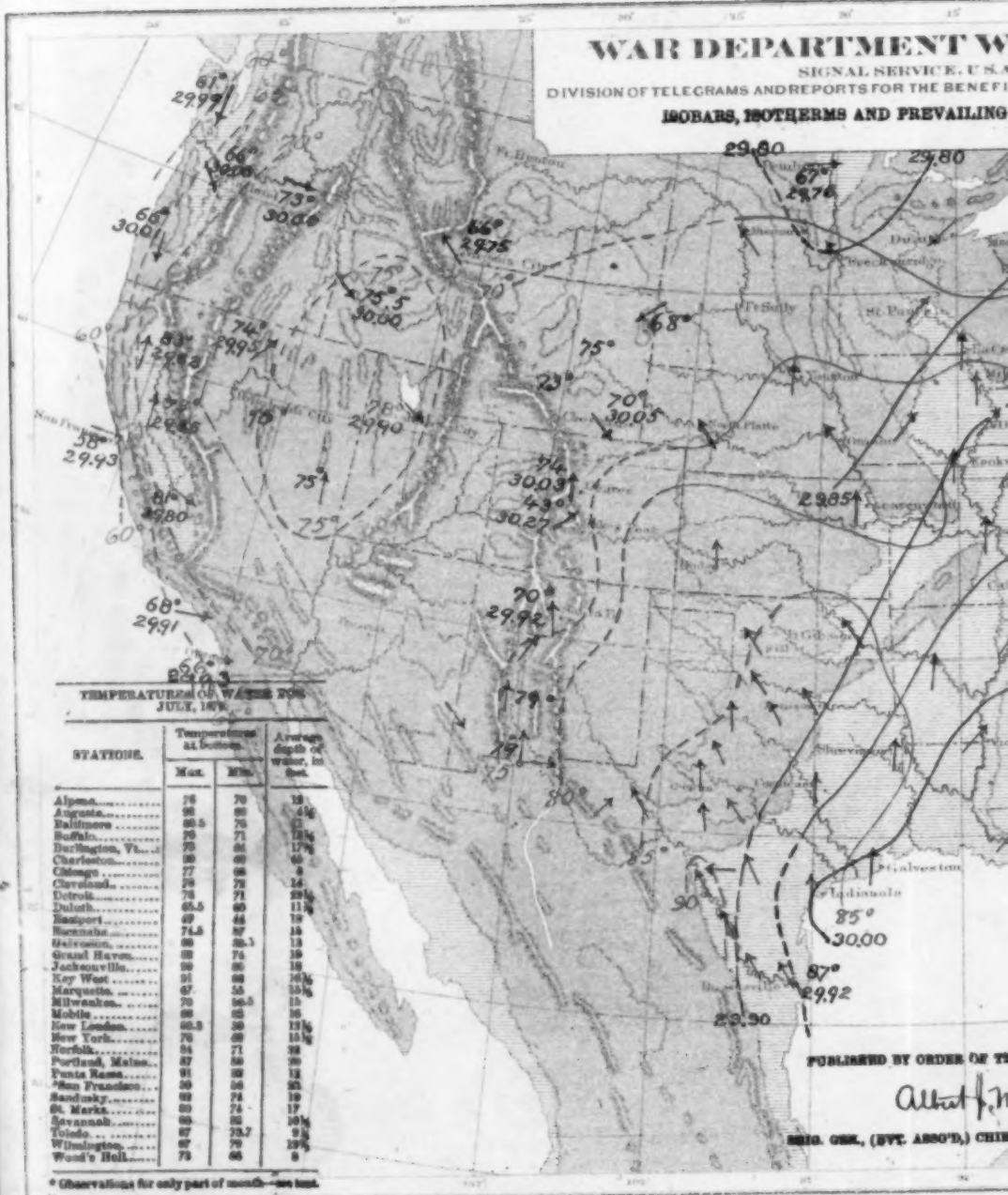
at Long. West from 82° Greenwich

NOTE.—The Roman letters show number and order of areas of low barometer. The figures above the lines show the days of the month; those below, 1, 2 and 3, indicate respectively the 7.30 A. M., the 4.30 P. M., and 11 P. M., (Washington mean time,) observations. The small circles on the lines indicate the position of the center of the area of low barometer at the day and hour written respectively above and below the line.

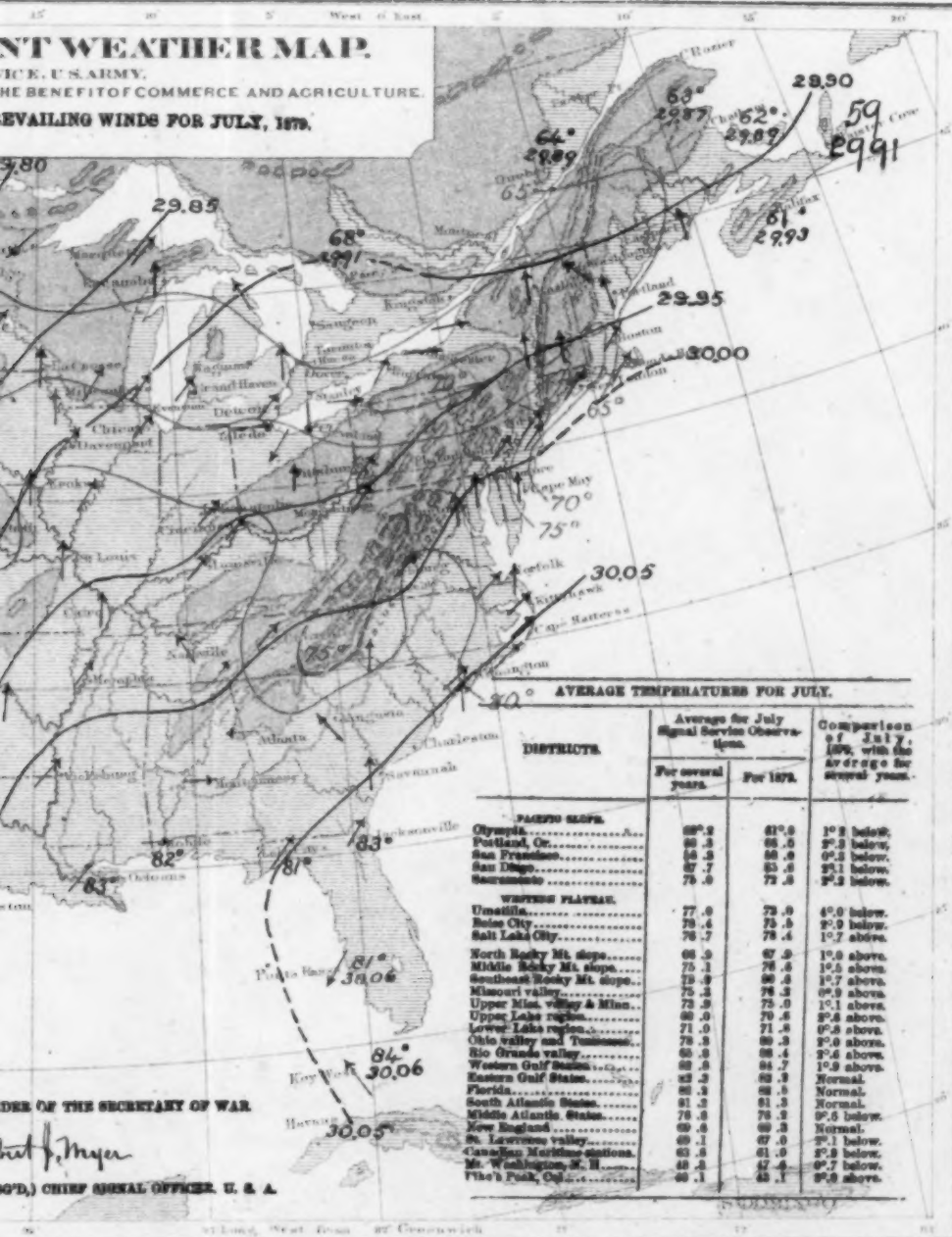
WAR DEPARTMENT W

SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT

ISOBARS, ISOTHERMS AND PREVAILING



No. II.



WAR DEPARTMENT
SIGNAL SERVICE
DIVISION OF TELEGRAMS AND REPORTS FOR THE BUREAU OF
PRECIPITATION CHART FOR

AVERAGE PRECIPITATION FOR JULY.

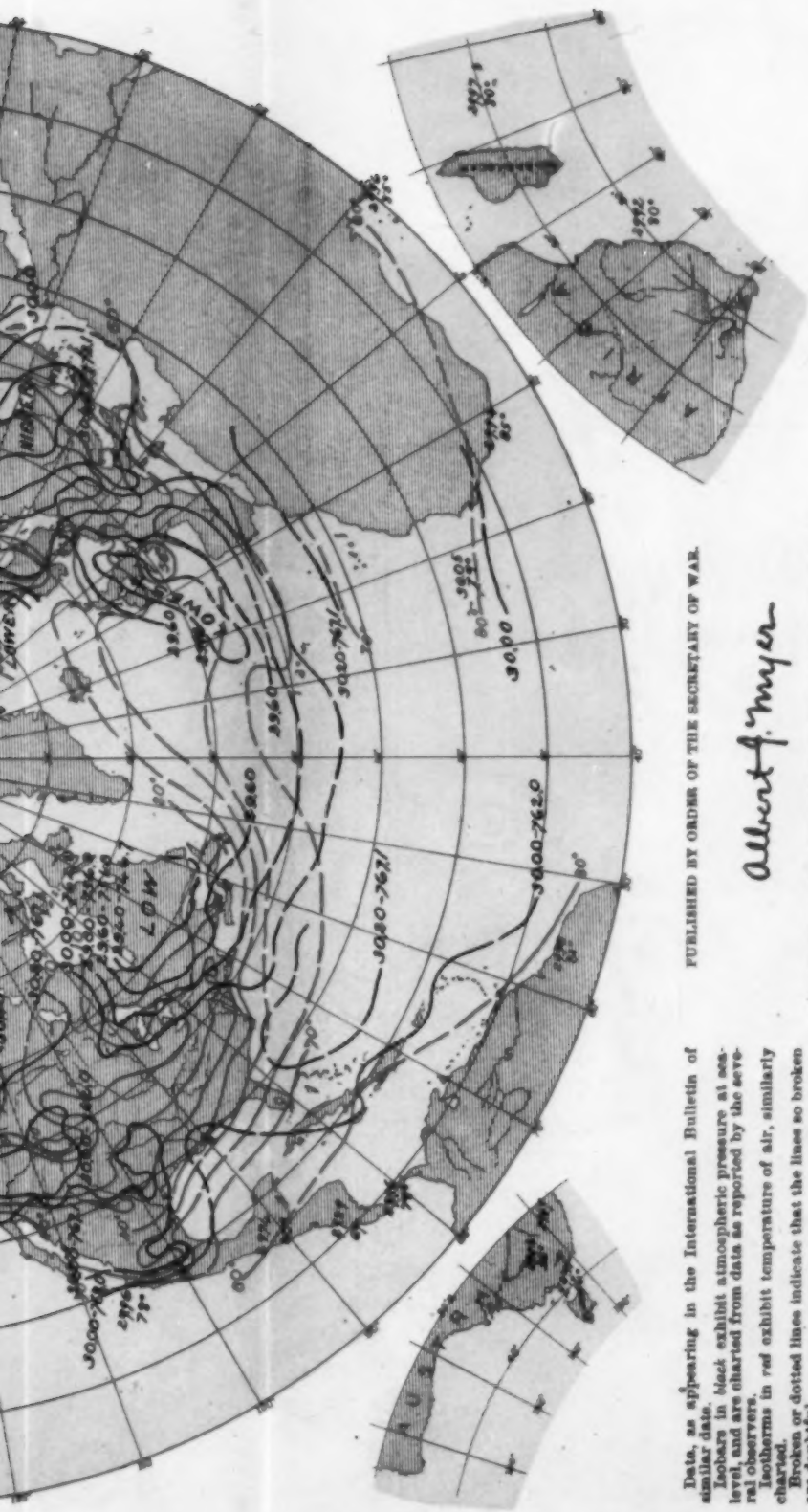
DISTRICTS.	Average for July.		Comparison of July, 1878, with the average for many years.
	For many years.	For 1878.	
St. Lawrence valley.....	1.67	1.67	0.70 excess.
New England.....	3.50	3.50	0.80 excess.
Middle Atlantic States.....	3.50	3.70	0.20 deficiency.
South Atlantic States.....	3.50	3.60	0.10 excess.
Eastern Gulf States.....	3.69	7.80	4.11 excess.
Western Gulf States.....	4.15	3.50	0.65 deficiency.
Tennessee.....	3.80	4.90	1.10 excess.
Ohio Valley.....	4.85	3.75	1.10 deficiency.
Lower Lake region.....	3.50	3.80	0.30 excess.
Upper Lake region.....	3.50	4.14	0.64 excess.
Upper Mississippi Valley.....	4.45	5.45	1.00 excess.
Minnesota.....	3.00	6.68	3.68 excess.
Lower Missouri Valley.....	3.00	3.30	0.30 excess.
Upper Missouri Valley.....	3.00	4.80	1.80 excess.
California Coast.....	3.00	3.00	0.00 excess.
Portland, Or.....	0.50	1.75	1.25 excess.

FORWARDED BY ORDER OF THE
SIGNAL SERVICE
ALBERT J. M.
SIGNAL GEN. (BYT. ASST. GEN.)

AVERAGE PRECIPITATION FROM JULY.			
DISTRICTS.	Average for July.		Comparison July, 1898, with the average for many years.
	For many years.	For 1898.	
	Inches.	Inches.	
St. Lawrence valley.....	2.47	1.26	0.75 excess.
New England.....	3.58	4.00	0.80 excess.
Middle Atlantic States.....	3.90	3.70	0.20 deficiency.
South Atlantic States.....	3.90	3.40	0.47 excess.
Western Gulf States.....	2.49	3.11	0.62 excess.
Western Gulf States.....	4.10	3.80	1.70 deficiency.
Tennessee.....	4.80	3.79	1.07 excess.
Ohio Valley.....	4.50	4.78	1.06 deficiency.
Lower Lake region.....	3.60	0.19	3.41 excess.
Upper Lake region.....	4.00	0.14	1.94 excess.
Upper Mississippi Valley.....	4.45	0.45	2.00 excess.
Minnesota.....	3.65	0.45	3.20 excess.
Lower Missouri Valley.....	2.00	0.30	0.49 deficiency.
Upper Missouri Valley.....	1.00	0.90	0.94 excess.
California Coast.....	0.00	0.00	0.40 deficiency.
Portland, Or.....	0.56	1.75	1.48 excess.







Data, as appearing in the International Bulletin of similar data. Isotherms in black exhibit atmospheric pressure at sea-level, and are charted from data as reported by the several observers. Isotherms in red exhibit temperature of air, similarly charted. Broken or dotted lines indicate that the lines so broken are doubtful. Arrows, when charted, fly with the wind and exhibit wind-direction and force.

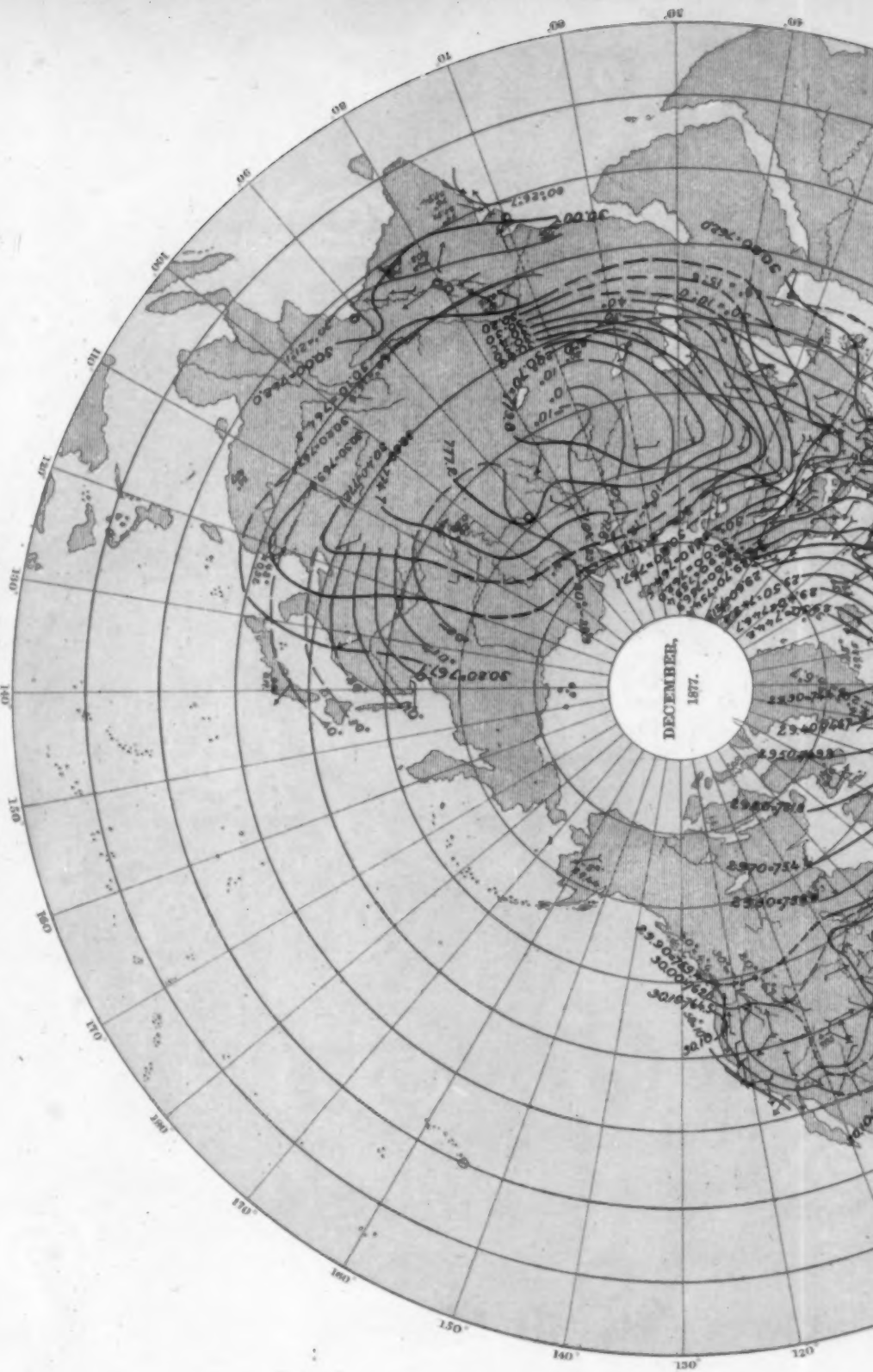
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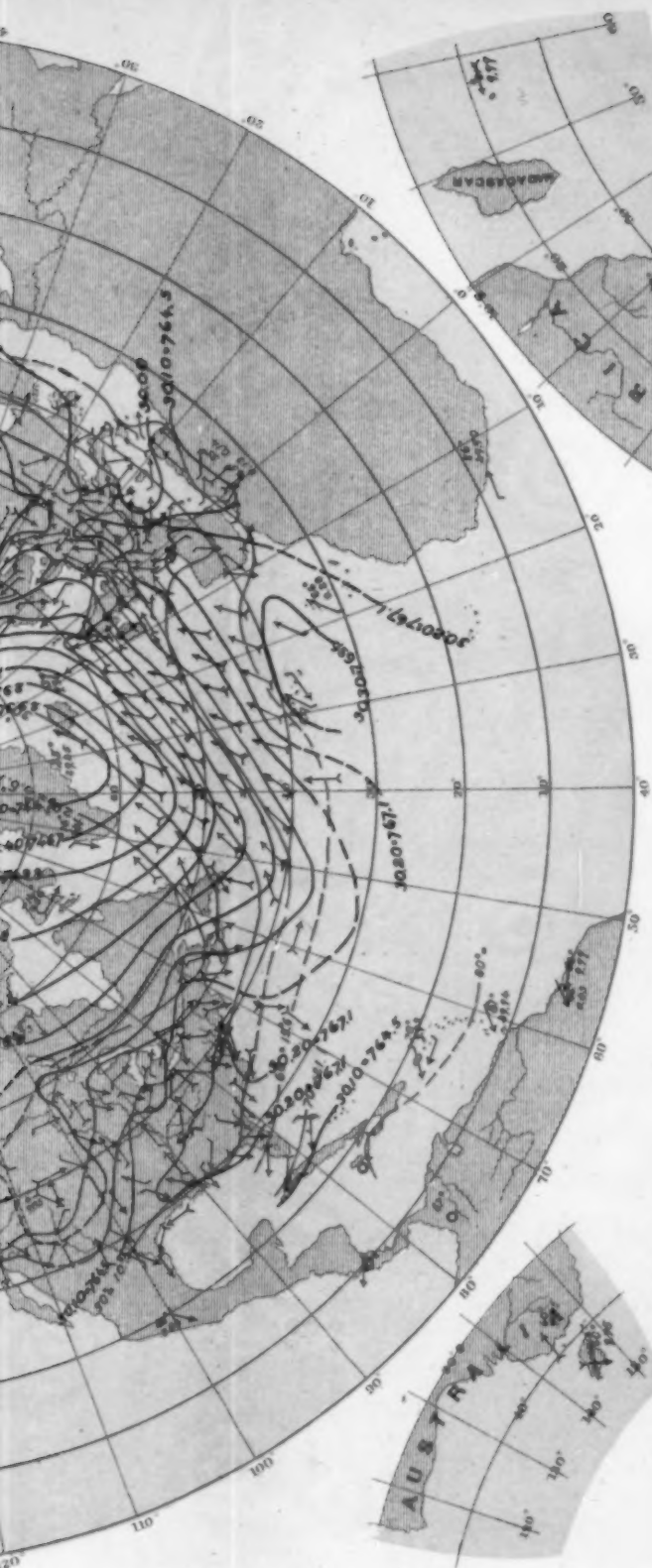
Albert F. Meyer

BRIG. GEN., (BVT. ASST'D.) CHIEF SIGNAL OFFICER, U. S. A.

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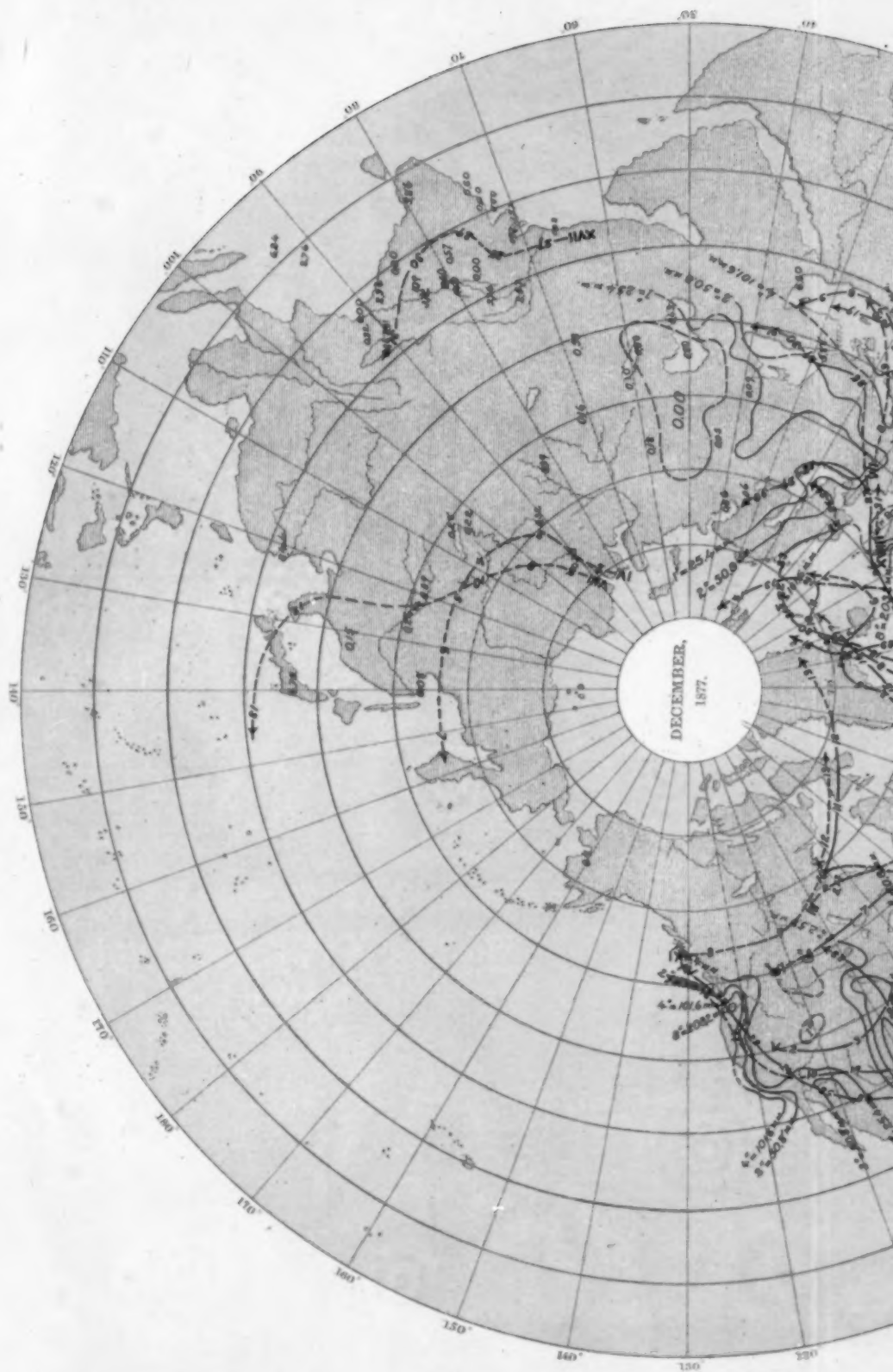
INTERNATIONAL MONTHLY CHART.
 Showing mean pressure, mean temperature, mean force and prevailing direction of winds at
 7:30 A. M., Washington mean time, for the month of December, 1877, based on
 the daily charts of the International Bulletin.

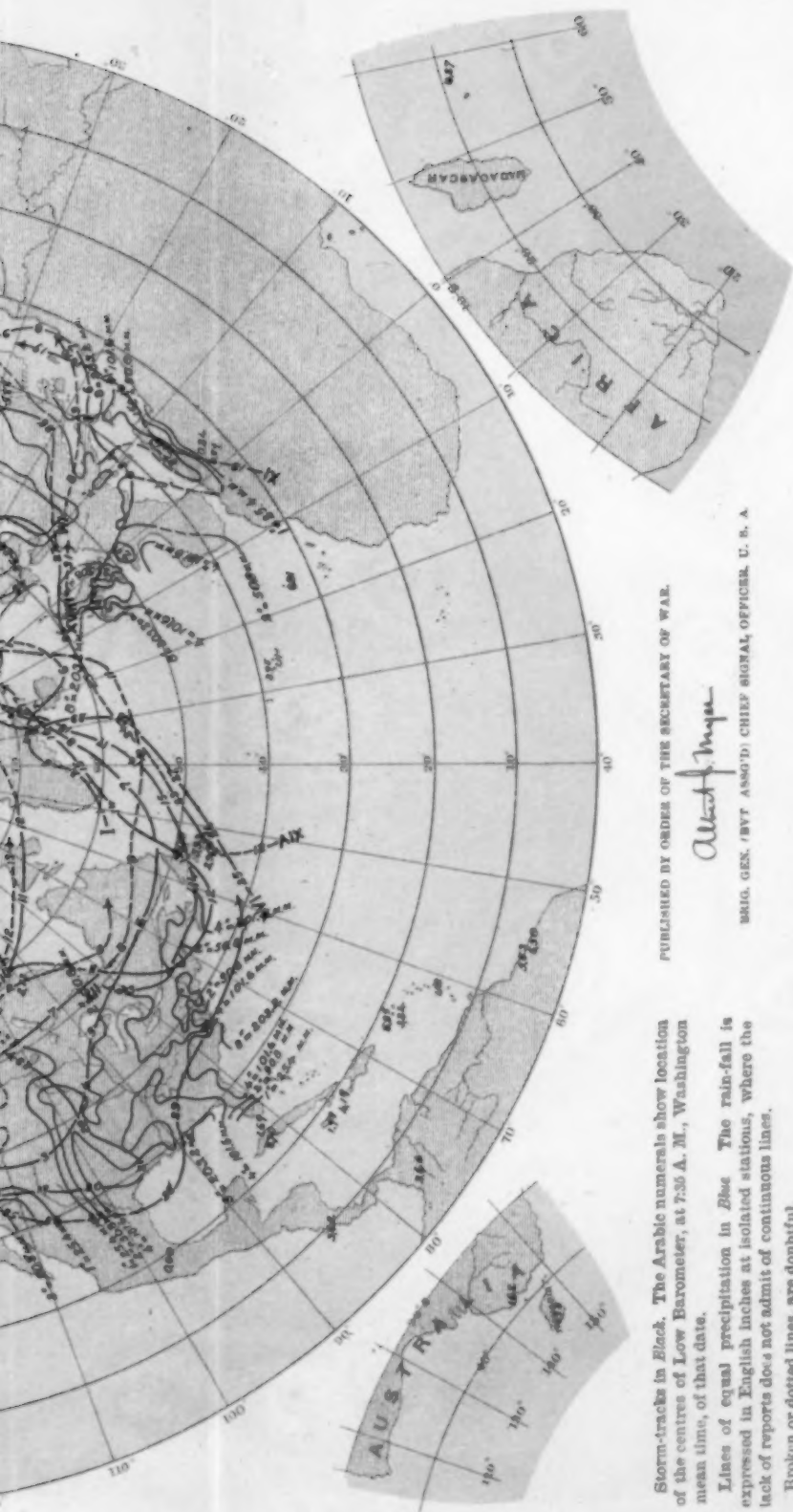




No. VI.

INTERNATIONAL CHART.
Showing Tracks of Centres of Low Barometer, and Precipitation Lines, for December, 1877.





Storm-tracks in *Black*. The Arabic numerals show location of the centres of Low Barometer, at 7:35 A. M., Washington mean time, of that date.

Lines of equal precipitation in *Blue* The rain-fall is expressed in English inches at isolated stations, where the lack of reports does not admit of continuous lines.

Broken or dotted lines, are doubtful.

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BRIG. GEN. (BVT ASSO'D) CHIEF SIGNAL OFFICER, U. S. A.

INDEX TO STORM-TRACKS

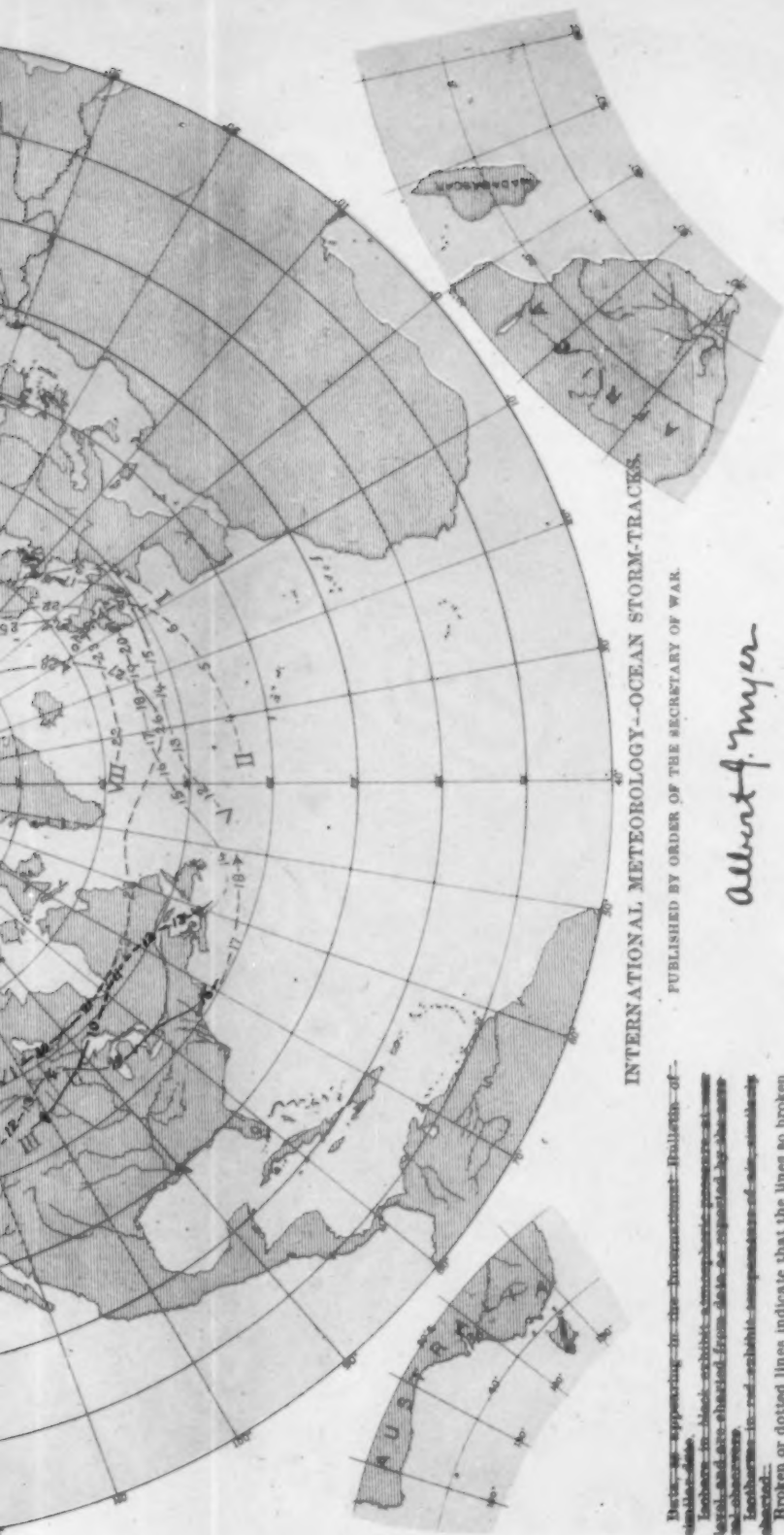
- Atlantic Ocean.*
- I. from June 2nd to 8th, 1878.
 - II. from June 14th to 16th, 1878.
 - III. from June 20th to 22nd, 1878.
 - IV. from June 28th to 30th, 1878.
 - V. from June 3rd to 5th, 1878.
 - VI. from June 11th to 13th, 1878.
 - VII. from June 19th to 21st, 1878.
- Pacific Ocean.*
- I. from April 24th to 26th, 1878.
 - II. from May 1st to 3rd, 1878.
 - III. from May 10th to 12th, 1878.
 - IV. from May 17th to 19th, 1878.
- Bay of Bengal.*
- I. from May 17th to 19th, 1878.

WINDS ACCOMPANYING THE ATLANTIC STORMS.

American Coast.				European Coast.			
No.	Date.	Direction.	Miles per Hour.	Date.	Direction.	Miles per Hour.	Remarks.
III.	June 14th.	SW	20 to 25	June 2nd.	SW to NW	17.0 to 21.2	

* Estimated from a scale of 0 to 3.





INTERNATIONAL METEOROLOGY--OCEAN STORM-TRACKS.

PUBLISHED BY ORDER OF THE SECRETARY OF WAR.

Tracks appearing in the International Bulletin of--
 are in black, exhibit temperature, pressure, at sea
 level, and are charted from data reported by the
 and observed.
 Tracks in red exhibit temperature of air, and are
 selected.

Broken or dotted lines indicate that the lines so broken
 are doubtful.
 Arrows, when charted, show with the wind and exhibit
 wind-direction and force.

The tracks charted in black have appeared in previous
 Reviews.

The tracks charted in red have been made from data col-
 lected since preceding Review.

Albert F. Meyer

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